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AN IMPACT ASSESSMENT OF GREAT LAKES AQUATIC NONINDIGENOUS SPECIES

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1. INTRODUCTION

1.1 Project Background

The Great Lakes are host to thousands of native fishes, invertebrates, plants, and other species that not only provide recreational and economic value to the region, but also hold an important ecological value. However, with over 180 documented aquatic nonindigenous species[1] and an invasion rate estimated at 1.3-1.8 species$\cdot$year^{-1}, the Great Lakes basin is considered one of the most heavily invaded aquatic systems in the world (GLRI Task Force 2010, Mills et al. 1993, Ricciardi 2006). Some of these nonindigenous species may become invasive (i.e. "those species whose introduction does or is likely to cause economic or environmental harm or harm to human health" (E.O. 13112, 1999)) and threaten the ecological and/or socio-economic value of the Great Lakes. In contrast, some nonindigenous species are capable of contributing value to the Great Lakes. Pacific salmonids, for instance, are stocked annually by the millions and provide a major support for the Great Lakes' multi-billion dollar fishery (Kocik and Jones 1999, Southwick Associates 2007, Talhelm 1985, USACE 2012, USFWS/GLFC 2010). Much of the recently funded research on aquatic nonindigenous species (ANS) has focused on fish and dreissenid mussels, but for most ANS in the Great Lakes, research has been limited and the extent of impact has not yet been assessed or estimated (Steinberg et al. 2007). While the consequences stemming from the introduction of nonindigenous species can be complex, understanding these impacts will foster more efficient conservation, management, and restoration efforts in the Great Lakes (Byers et al. 2002).

This purpose of this study is to provide a baseline assessment of realized, potential, and unknown impacts for established nonindigenous species in the Great Lakes. An organism impact assessment (OIA) tool was developed in order to analyze the extent of each species' impact in a standardized manner. Following a thorough literature review, the OIA was used to rank the environmental impact, socio-economic impact, and beneficial effect of each species as high, moderate, low, or unknown. Importantly, this ranking system provides a method of identifying and comparing impacts across taxa and type of impact.

This effort is part of a larger project funded by the Great Lakes Restoration Initiative that will eventually also assess the potential impact of species predicted as likely to invade the Great Lakes as well as management options for established and potential invasives. The final products

[1] These nonindigenous aquatic species have populations established in the Great Lakes basin below the ordinary high water mark, including connecting channels, wetlands, and waters ordinarily attached to the Lakes (see definitions and criteria for listing in the Great Lakes Aquatic Nonindigenous Species Information System at http://www.glerl.noaa.gov/res/Programs/glansis/glansis.html).

of the project will include both qualitative (high, moderate, low) rankings of impact for each species as well as an updated review of the available impact-related research. This information is being made available to scientists, managers, and the public through the Great Lakes Aquatic Nonindigenous Species Information System (GLANSIS), an online database containing information on the identification, distribution, ecology, and impact of all established ANS in the Great Lakes.

1.2 Review of Impact Assessments

With respect to nonindigenous species, risk assessments of potential invaders have been more commonly conducted than have impact assessments; however, similar methodology can be applied to both forms of assessment. Parker (1999) suggests that the development of both risk and impact assessments is based on three primary steps: (1) identify the metrics by which impacts or risks will be measured, (2) develop a system to sum or quantify these metrics into a final measure or score, and (3) use public values to determine the weight that various risks or impacts should hold during assessment. Most assessment tools developed for nonindigenous species rely upon these principles; some depend on primarily quantitative systems, while others are primarily qualitative in nature (Dahlstrom et al. 2011, Leung and Dudgeon 2008).

A common component of quantitative assessments is the use of numerical values and calculations to produce a final quantitative sum of risk or impact. Certain additive probabilities or currencies are often designated as proxies of risk or impact in mathematical models or other forms of analysis (e.g., Kolar and Lodge 2001, Leung et al. 2002). Benefit-cost analyses typically measure impact according to an estimate of financial cost (e.g., Pimentel 2005), while other assessments may depend on quantities such as invader abundance or range size as addends or factors of an impact score (Parker 1999). Additionally, some of these quantities, including change in species richness values or change in densities of native biomass, incorporate specific impacts into assessments (Thiele et al. 2010). While the use of numerical proxies of impact—which are inherently measureable or calculable—suggests higher levels of objectivity and consistency in the assessment process, quantitative assessments may fail to account for all types of impacts. Moreover, they may depend on models, calculation methods, or proxies that do not accurately reflect impact and are often difficult to complete when available data is limited (Leung and Dudgeon 2008, Thiele et al. 2010). The latter is a particular issue for many of the over 180 ANS in the Great Lakes basin.

In contrast, managers often prioritize funding and management efforts for nonindigenous species by collecting information, evaluating socio-economic and environmental concerns, and determining relative levels of impact with the assistance of expert opinion (e.g., Mills et al. 1993). Many impact and risk assessment systems are similarly qualitative in nature, using a combination of the available literature and expert judgment to estimate the extent of impact. While quantitative values (e.g., monetary cost or species abundance) are often taken into account, they act as a guide in impact assessment rather than being used to calculate an impact score directly. For instance, many risk and impact assessments apply information to an independently-derived scoring system, which may provide either numerical or categorical scores for each type of impact depending on its extent, and can be designed to calculate an overall rank (e.g., Copp et al. 2005, EPPO 1997, Nentwig et al. 2010, Pheloung et al. 1999, Risk Assessment and Management Committee 1996). While such systems may be more capable of including a wider variety of impacts and can function in the absence of the data on which quantitative systems rely, qualitative assessment systems have received criticism for being too subjective, implementing inaccurate scoring systems, and lacking transparency, consistency, and repeatability (Holt 2006, Leung and Dudgeon 2008, Parker 1999).

This project seeks to identify and compare the realized impacts of all ANS in the Great Lakes basin. Given the large scale of this effort, the wide variability in taxa and available information, and the desire to account for as many impacts as possible, a primarily qualitative approach was chosen. Like many risk and impact assessments, it depends on a customized scoring system that can account for qualitative information across taxa.

2. METHODS

2.1 Overview of Organism Impact Assessment Structure

A species-specific impact assessment tool was developed for Great Lakes nonindigenous species as a questionnaire with three main categories of impact: environmental, socio-economic, and beneficial. The impact categories and criteria to be considered in each (see section 2.2) were based on a literature review of the potential impacts of aquatic nonindigenous species as well as on previously implemented impact assessment systems. Three categories were chosen in order to incorporate both impacts perceived as adverse (i.e. environmental and socio-economic) and serviceable (i.e. beneficial), as both types of impacts often have important influence in an area (Gonzlan et al. 2010, Park 2004). Analysis of socio-economic impacts independent of environmental impacts allowed those consequences with direct implications for human values to be evaluated and ranked separately from general environmental impacts. The impact assessment was largely designed to reflect realized impact in the Great Lakes region; however, the assessment did take significant impacts of invasion outside of the Great Lakes into account (see section 2.3).

For each impact category, established species were assessed according to six criteria. Each criterion was expressed as a question followed by four possible responses. Each response described a different extent of the impact and was associated with a corresponding score (see section 2.3). Descriptions and benchmarks of impact extent were intended to be as objective as possible, avoiding the use of value-laden ranking terms (i.e. high, moderate, low). Scores for each criterion were summed, and a scoring table was established for conversion of the final score into an overall impact rank.

A panel of experts on aquatic nonindigenous species in the Great Lakes basin (See 5 Acknowledgements) provided external review of the impact assessment tool and the assessment results throughout the development and implementation process.

2.2 Criteria Assessed

The criteria included in each impact category were developed with several considerations in mind. A significant goal was to incorporate criteria in each impact category that covered the full range of potential impacts in aquatic systems. However, another strong consideration was the need to implement criteria applicable to all nonindigenous taxa. By standardizing the assessment process across taxa, the resulting ranks for all 180+ Great Lakes invaders can be directly compared.

2.2.1 Environmental Impact

Criteria in this category include those impacts that affect biotic and/or abiotic components of the ecosystem relative to pre-invasion conditions. ANS can affect native species on multiple scales, including the individual, the population, and the community level. Some of these impacts are due to direct interactions between native and nonindigenous species, such as predation or parasitism. However, indirect effects through alterations of the physical environment or the trophic web can also be numerous. Environmental impacts were consolidated into six main criteria: facilitation of parasitism, viral/bacterial infections, or toxicity; competition; food-web effects; genetic effects; degradation of water quality; and degradation of physical habitat.

2.2.2 Socio-economic Impact

Criteria in this category include those impacts that directly affect societal or individual values relative to pre-invasion conditions. The natural resources of the Great Lakes are used by citizens in many ways, so the potential for socio-economic impacts following an invasion is significant. Thus, while some of the included potential impacts apply to invasions universally, many have a unique influence in the Great Lakes. The socio-economic impacts were consolidated into six main criteria: human health effects, infrastructural damage, degradation of water quality (related to human use), harm to economic sectors, harm to recreational potential, and diminishment of aesthetic quality.

2.2.3 Beneficial Effect

In order for this OIA tool to be accurate in its assessment and most useful for managers, both the adverse and beneficial effects must be accounted for (Risk Assessment and Management Committee 1996). Criteria in this category include those impacts perceived as advantageous or serviceable to either the ecosystem or human values. While some ANS in the Great Lakes are actively controlled because of their adverse impacts (e.g., sea lamprey, *Petromyzon marinus*) (Jones 2007), other ANS have resulted in, or been purposefully introduced for, some benefit to humans. Beneficial effects were consolidated into six main criteria: use as a biocontrol agent, commercial value, recreational value, medicinal/scientific value, improvement to water quality, and other ecological services.

2.3 Scoring

Six criteria for each impact category were presented in question format with four possible responses. Three of these responses were scored as ‘0’, ‘1’, or ‘6’ depending on the extent of impact; in general, these reflected little to no significance, moderate significance, and high significance, respectively. The fourth possible selection allowed an impact to be assessed as 'unknown' if available information was insufficient for proper assessment. Only realized impacts in the Great Lakes warranted a high impact ranking for any given criterion. However, in many cases, a record of invasion describing significant impacts elsewhere (i.e. high potential impact) was considered sufficient evidence to warrant a moderate impact ranking for a given criterion. These particular cases were noted in the assessment.

Detailed guidelines were established to ensure consistency, transparency, and reproducibility across all investigators involved in the assessments for cases requiring the use of best judgement.

Of particular note, if the potential for particular direct human impact was neither noted in the literature, in popular media, nor could be inferred from a significant environmental impact, socio-economic and beneficial criteria were assessed as insignificant rather than unknown. This reflects a perception that impacts significant to society are unlikely to go without mention in the literature. In contrast, the environmental impact assessment was completed with a much heavier use of the precautionary principle, recognizing that any established nonindigenous organism will interact with the existing ecosystem in some manner. Thus, a lack of research was not assumed to infer a lack of impact.

The numerical values corresponding to each score worked in conjunction with the scoring system to ensure that species with highly significant impacts for any criterion ranked as a high-impact species overall in that category. In contrast, moderately significant impacts in all six criteria were required to assess a species as high-impact. A species could only be ranked as a low-impact species for a given category if it lacked impacts of high significance and demonstrated a limited number of moderately significant and unknown impacts for the six criteria. The full interpretation of these scores is given in Table 1. The range of scores for each category was 0-36, while 'unknown' scores in each sub-assessment ranged from 0-6.

Table 1 Interpretive scoring table for a given category of impact. Each category contained six questions that could receive a score of '0', '1', '6' or 'U' (unknown) corresponding to the extent of that particular impact. The qualitative statements describe the intended interpretation of each rank.

Scoring			**Qualitative Statement**
Score	# Unknowns	Species Impact	
>5	Any	High	*Species X* has a high impact in the Great Lakes.
2-5	Any	Moderate	*Species X* has a moderate impact in the Great Lakes.
0	0-1	Low	There is little or no evidence to support that *Species X* has significant impacts in the Great Lakes.
1	0		
0	≥2	Unknown	Current research on the impact of *Species X* in the Great Lakes is inadequate to support proper assessment.
1	≥1		

3. RESULTS

Organism impact assessment scores for established aquatic nonindigenous species in the Great

Lakes basin are given in Tables 2-11, organized by taxonomic group. Taxonomic groups included fishes (n=28), annelids (n=6), arthropods (non-crustacean) (n=2), bryozoans (n=1), coelenterates (n=2), crustaceans (n=20), mollusks (n=18), plants (n=55), algae (n=27), testate amoebae (n=3), and parasites/diseases (n=20). For each species, the numeric score, number of unknowns, and overall rank of impact for each impact category are given.

3.1 Fishes

Table 2 Organism impact assessment scores for established fishes in the Great Lakes basin.

Scientific Name	Common Name	Family	Environmental		Socio-Economic		Beneficial	
			Score	# Unknown	Score	# Unknown	Score	# Unknown
Alosa aestivalis	Blueback herring	Clupeidae	Unknown		Low		Low	
			0	3	0	0	0	1
Alosa pseudoharengus	Alewife	Clupeidae	High		High		High	
			18	2	14	0	7	1
Apeltes quadracus	Fourspine stickleback	Gasterosteidae	Unknown		Low		Low	
			0	4	0	0	0	1
Carassius auratus	Goldfish	Cyprinidae	Unknown		Low		Unknown	
			1	3	0	1	0	2
Cyprinus carpio	Common carp	Cyprinidae	High		Unknown		High	
			12	2	1	2	8	0
Enneacanthus gloriosus	Bluespotted sunfish	Centrarchidae	Unknown		Low		Unknown	
			0	6	0	1	0	2
Esox niger	Chain pickerel	Esocidae	Unknown		Low		Low	
			1	4	0	1	1	0
Gambusia affinis	Western mosquitofish	Poeciliidae	Unknown		Low		Unknown	
			0	4	0	1	1	2
Gymnocephalus cernua	Ruffe	Percidae	Moderate		Unknown		Low	
			2	2	0	3	0	0
Lepisosteus platostomus	Shortnose gar	Lepisosteidae	Unknown		Low		Low	
			0	4	0	1	0	0
Lepomis humilis	Orangespotted sunfish	Centrarchidae	Unknown		Low		Unknown	
			0	5	0	1	0	2
Lepomis microlophus	Redear sunfish	Centrarchidae	Moderate		Low		Moderate	
			2	2	0	0	2	0
Misgurnus anguillicaudatus	Oriental weatherfish	Cobitidae	Unknown		Low		Low	
			0	5	0	1	0	1
Morone americana	White perch	Moronidae	High		Moderate		High	
			18	0	2	1	7	0
Neogobius melanostomus	Round goby	Gobiidae	High		High		Low	
			13	2	13	0	1	0
Notropis buchanani	Ghost shiner	Cyprinidae	Unknown		Low		Low	
			0	5	0	0	0	1
Noturus insignis	Margined madtom	Ictaluridae	Unknown		Low		Low	
			1	4	0	0	0	1
Oncorhynchus gorbuscha	Pink salmon	Salmonidae	Unknown		Low		Moderate	
			1	3	1	0	2	1
Oncorhynchus kisutch	Coho salmon	Salmonidae	Moderate		Low		High	
			3	2	0	0	12	0
Oncorhynchus mykiss	Rainbow trout	Salmonidae	High		Low		High	
			9	2	0	1	12	2
Oncorhynchus nerka	Kokanee salmon	Salmonidae	Unknown		Low		Low	
			0	4	0	0	1	0
Oncorhynchus tshawytscha	Chinook salmon	Salmonidae	Moderate		Low		High	
			2	3	0	0	13	1

<table>
<tr><td rowspan="2">Osmerus mordax</td><td rowspan="2">Rainbow smelt</td><td rowspan="2">Osmeridae</td><td colspan="2">High</td><td colspan="2">Unknown</td><td colspan="2">High</td></tr>
<tr><td>12</td><td>2</td><td>0</td><td>3</td><td>14</td><td>0</td></tr>
<tr><td rowspan="2">Petromyzon marinus</td><td rowspan="2">Sea lamprey</td><td rowspan="2">Petromyzontidae</td><td colspan="2">High</td><td colspan="2">High</td><td colspan="2">Low</td></tr>
<tr><td>12</td><td>0</td><td>18</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">Phenacobius mirabilis</td><td rowspan="2">Suckermouth minnow</td><td rowspan="2">Cyprinidae</td><td colspan="2">Low</td><td colspan="2">Low</td><td colspan="2">Low</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td rowspan="2">Proterorhinus semilunaris</td><td rowspan="2">Tubenose goby</td><td rowspan="2">Gobiidae</td><td colspan="2">Unknown</td><td colspan="2">Low</td><td colspan="2">Low</td></tr>
<tr><td>0</td><td>3</td><td>0</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">Salmo trutta</td><td rowspan="2">Brown trout</td><td rowspan="2">Salmonidae</td><td colspan="2">High</td><td colspan="2">Low</td><td colspan="2">High</td></tr>
<tr><td>9</td><td>2</td><td>0</td><td>1</td><td>6</td><td>0</td></tr>
<tr><td rowspan="2">Scardinius erythrophthalmus</td><td rowspan="2">Rudd</td><td rowspan="2">Cyprinidae</td><td colspan="2">Moderate</td><td colspan="2">Unknown</td><td colspan="2">Unknown</td></tr>
<tr><td>3</td><td>2</td><td>0</td><td>2</td><td>1</td><td>2</td></tr>
</table>

Available information was insufficient to judge the environmental impacts for 14 species, the socio-economic impact for 4 species, and beneficial impacts for 4 species. Particularly lacking was information on the impacts of fishes on the physical environment and water quality.

Only one species – *Oncorhynchus kisutch* - scored as highly beneficial with only moderate environmental and low socio-economic impact. All other highly beneficial species also had offsetting high negative impacts. One fish species - *Alosa pseudoharengus* - scored high on all three assessments (high environmental, socio-economic, AND beneficial impacts). Five fish species - *Cyprinus carpio*, *Morone americana, Oncorhynchus mykiss, Osmerus mordax,* and *Salmo trutta* - scored as highly beneficial, but with offsetting high negative environmental impacts.

Two fish species - *Neogobius melanostomus* and *Petromyzon marinus* - were assessed as having high environmental and socio-economic impacts, but low benefits.

Three additional species – *Gymnocephalus cernuus*, *Lepomis microlophus*, and *Scardinius erythrophthalmus* - were determined to have moderate environmental impacts (with low or unknown socioeconomic impacts and benefits).

Only *Phenacobious mirabilis* scored as low impact on all three assessments.

3.2 Annelids

Table 3 Organism impact assessment scores for established nonindigenous annelids in the Great Lakes basin.

<table>
<tr><th rowspan="2">Scientific Name</th><th rowspan="2">Common Name</th><th rowspan="2">Family</th><th colspan="2">Environmental</th><th colspan="2">Socio-Economic</th><th colspan="2">Beneficial</th></tr>
<tr><th>Score</th><th># Unknown</th><th>Score</th><th># Unknown</th><th>Score</th><th># Unknown</th></tr>
<tr><td rowspan="2">Branchiura sowerbyi</td><td rowspan="2">Tubificid worm</td><td rowspan="2">Tubificidae</td><td colspan="2">Unknown</td><td colspan="2">Low</td><td colspan="2">Unknown</td></tr>
<tr><td>1</td><td>5</td><td>0</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td rowspan="2">Gianius aquaedulcis</td><td rowspan="2">Tubificid worm</td><td rowspan="2">Tubificidae</td><td colspan="2">Unknown</td><td colspan="2">Low</td><td colspan="2">Low</td></tr>
<tr><td>0</td><td>6</td><td>0</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">Potamothrix bedoti</td><td rowspan="2">Tubificid worm</td><td rowspan="2">Tubificidae</td><td colspan="2">Unknown</td><td colspan="2">Low</td><td colspan="2">Low</td></tr>
<tr><td>0</td><td>6</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td rowspan="2">Potamothrix moldaviensis</td><td rowspan="2">Tubificid worm</td><td rowspan="2">Tubificidae</td><td colspan="2">Unknown</td><td colspan="2">Low</td><td colspan="2">Low</td></tr>
<tr><td>0</td><td>6</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td rowspan="2">Potamothrix vejdovskyi</td><td rowspan="2">Tubificid worm</td><td rowspan="2">Tubificidae</td><td colspan="2">Unknown</td><td colspan="2">Low</td><td colspan="2">Low</td></tr>
<tr><td>0</td><td>6</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td rowspan="2">Ripistes parasita</td><td rowspan="2">Oligochaete</td><td rowspan="2">Naididae</td><td colspan="2">Unknown</td><td colspan="2">Low</td><td colspan="2">Low</td></tr>
<tr><td>0</td><td>6</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
</table>

Available information was insufficient to determine the environmental impact of any of the nonindigenous annelids. Direct socio-economic impact of these species is low. Beneficial impact is also low for most annelids, though information for *Brachiura sowerbyi* was insufficient to determine benefits.

3.3 Arthropods (Non-crustacean)

Table 4 Organism impact assessment scores for established nonindigenous arthropods in the Great Lakes basin.

Scientific Name	Common Name	Family	Environmental		Socio-Economic		Beneficial	
			Score	# Unknown	Score	# Unknown	Score	# Unknown
Acentria ephemerella	Water moth	Crambidae	Unknown		Low		Moderate	
			1	3	0	1	2	2
Tanysphyrus lemnae	Duckweed weevil	Erirhinidae	Unknown		Low		Low	
			0	4	0	0	0	1

Acentria epemerella has some capacity for bio-control of the nonindigenous *Myriophyllum spicatum* which was assessed here as a moderate beneficial impact. These two insect species otherwise have no socio-economic or beneficial impact. More information is needed as to the way these species interact with native species (competition, predator-prey) and environment (physical and water quality) in order to determine their environmental impacts.

3.4 Bryozoans

Table 5 Organism impact assessment scores for established nonindigenous bryozoans in the Great Lakes basin.

Scientific Name	Common Name	Family	Environmental		Socio-Economic		Beneficial	
			Score	# Unknown	Score	# Unknown	Score	# Unknown
Lophopodella carteri	Freshwater bryozoan	Olindiidae	Unknown		Unknown		Low	
			0	4	0	4	0	1

The one nonindigenous bryozoan was assessed to have little to no benefit in the Great Lakes region. Available information is insufficient to determine whether or not it has significant environmental or socioeconomic impacts.

3.5 Coelenterates

Table 6 Organism impact assessment scores for established nonindigenous coelenterates in the Great Lakes basin.

Scientific Name	Common Name	Family	Environmental		Socio-Economic		Beneficial	
			Score	# Unknown	Score	# Unknown	Score	# Unknown
Cordylophora caspia	Freshwater hydroid	Clavidae	Unknown		Unknown		Low	
			0	4	1	2	0	1
Craspedacusta sowerbyi	Freshwater jellyfish	Olindiidae	Unknown		Low		Low	
			0	4	0	1	0	1

The two nonindigenous coelenterates were assessed to have little to no benefit in the Great Lakes region. *Craspedacusta sowerbyi* was determined to have little to no socioeconomic impact. More information is needed on the realized impact of *Cordylophora caspia* on recreation and aesthetics in order to determine whether it has significant socio-economic impact. Current information is insufficient to determine the environmental impact of these two species.

3.6 Crustaceans

Table 7 Organism impact assessment scores for established nonindigenous crustaceans in the Great Lakes basin.

Scientific Name	Common Name	Family	Environmental		Socio-Economic		Beneficial	
			Score	# Unknown	Score	# Unknown	Score	# Unknown
Argulus japonicus	Parasitic oarsman	Argulidae	Unknown		Unknown		Low	
			1	2	0	3	0	0
Bythotrephes longimanus	Spiny waterflea	Cercopagidae	High		Low		Low	
			7	2	1	0	0	0
Cercopagis pengoi	Fishhook waterflea	Cercopagidae	High		Low		Low	
			7	2	1	0	0	1
Cyclops strenuus	Oarsman	Cyclopidae	Unknown		Low		Low	
			1	2	1	0	0	0
Daphnia galeata galeata	Waterflea	Daphniidae	Unknown		Low		Low	
			1	2	0	0	0	0
Daphnia lumholtzi	Waterflea	Daphniidae	Unknown		Low		Unknown	
			0	4	0	1	1	1
Echinogammarus ischnus	Scud	Gammaridae	Moderate		Low		Low	
			2	1	0	0	0	0
Eubosmina coregoni	Waterflea	Bosminidae	Unknown		Low		Low	
			0	4	0	0	1	0
Eubosmina maritima	Cladoceran	Bosminidae	Unknown		Low		Low	
			0	2	0	0	0	0
Eurytemora affinis	Oarsman	Temoridae	Unknown		Unknown		Low	
			0	5	0	3	0	1
Gammarus tigrinus	Amphipod	Gammaridae	Unknown		Low		Low	
			0	4	0	0	0	1
Hemimysis anomala	Bloody red shrimp	Mysidae	Unknown		Low		Low	
			0	5	0	1	0	1
Heteropsyllus nr. *nunni*	Oarsman	Canthocamptid a	Unknown		Low		Low	
			0	2	0	0	0	0
Megacyclops viridis	Oarsman	Cyclopidae	Unknown		Low		Low	
			0	2	0	0	0	1
Neoergasilus japonicus	Parasitic oarsman	Ergasilidae	Unknown		Low		Low	
			1	2	0	1	0	0
Nitokra hibernica	Oarsman	Ameiridae	Unknown		Low		Low	
			1	2	0	0	0	0
Nitokra incerta	Oarsman	Ameiridae	Unknown		Low		Low	
			1	2	0	0	0	0
Salmincola lotae	Parasitic oarsman	Lernaeopodidae	Unknown		Low		Low	
			1	2	0	0	0	0
Schizopera borutzkyi	Oarsman	Diosaccidae	Unknown		Low		Low	
			0	2	0	0	0	1
Skistodiaptomus pallidus	Oarsman	Diaptomidae	Unknown		Low		Low	
			0	5	0	0	0	0

The two nonindigenous raptorial waterfleas – *Bythotrephes longimanus* and *Cercopagis pengoi* – were determined to have high environmental impact. *Echinogammarus ischnus* was determined to have a moderate environmental impact. Information on the other 17 crustacean species – especially with regard to their interactions with native species - was insufficient to determine their environmental impact. For all but two of the species, information was sufficient to determine that socio-economic impact was low (the remaining two were unknown). For all but one species, information was sufficient to determine that the species brought little to no benefit to the Great Lakes (*Daphnia lumholtzi* assessed as unknown benefits).

3.7 Mollusks

Table 8 Organism impact assessment scores for established nonindigenous mollusks in the Great Lakes basin.

Scientific Name	Common Name	Family	Environmental		Socio-Economic		Beneficial	
			Score	# Unknown	Score	# Unknown	Score	# Unknown
Bithynia tentaculata	Faucet snail	Bithyniidae	High		Moderate		Low	
			7	4	2	2	1	0
Cipangopaludina chinensis malleata	Chinese mystery snail	Viviparidae	Unknown		Unknown		Low	
			0	5	0	2	0	1
Cipangopaludina japonica	Japanese mystery snail	Viviparidae	Unknown		Unknown		Unknown	
			0	5	0	3	0	2
Corbicula fluminea	Asian clam	Corbiculidae	Moderate		Moderate		Unknown	
			2	2	2	0	1	1
Dreissena bugensis	Quagga mussel	Dreissenidae	High		High		Low	
			25	0	20	0	1	0
Dreissena polymorpha	Zebra mussel	Dreissenidae	High		High		Low	
			30	0	25	0	1	0
Elimia virginica	Piedmont elimia	Pleuroceridae	Unknown		Low		Low	
			1	5	0	0	0	0
Gillia altilis	Buffalo pebblesnail	Hydrobiidae	Unknown		Low		Low	
			0	4	0	0	0	0
Lasmigona subviridis	Green floater	Unionidae	Low		Low		Low	
			0	0	0	0	0	0
Pisidium amnicum	Greater European peaclam	Sphaeriidae	Unknown		Low		Low	
			0	5	0	0	0	0
Pisidium henslowanum	Henslow peaclam	Sphaeriidae	Unknown		Low		Low	
			0	5	0	0	0	0
Pisidium moitessierianum	Pygmy peaclam	Sphaeriidae	Unknown		Low		Low	
			0	5	0	0	0	0
Pisidium supinum	Humpbacked peaclam	Sphaeriidae	Unknown		Low		Low	
			0	5	0	0	0	0
Potamopyrgus antipodarum	New Zealand mudsnail	Hydrobiidae	Moderate		Unknown		Low	
			2	3	1	1	1	0
Radix auricularia	European earsnail	Lymnaeidae	Unknown		Low		Low	
			1	4	1	0	0	0
Sphaerium corneum	European fingernail clam	Pisidiidae	Unknown		Low		Low	
			0	5	0	1	1	0
Valvata piscinalis	European stream valvata	Valvatidae	Unknown		Low		Low	
			0	5	0	0	0	0
Viviparus georgianus	Banded mystery snail	Viviparidae	Unknown		Low		Low	
			0	4	0	0	0	0

No mollusk species were assessed as having significant benefits to the Great Lakes region, though information on the two mystery snails of the genus *Cipangopaludina* was insufficient to determine whether they were beneficial or not.

The two nonindigenous dreissenid mussels were assessed as having high environmental and socioeconomic impacts. *Bithynia tentaculata* was also assessed as having high environmental impact, with only moderate socio-economic impact and little-to-no offsetting benefit. *Corbicula fluminea* was assessed as having moderate environmental and socioeconomic impact, and *Potamopyrgus antipodarum* was assessed as having moderate environmental impact with unknown socioeconomic impact. Only *Lasmigona subviridis*, which is native to adjacent drainages of the Atlantic slope, was assessed as having little to no impact. For the remaining dozen mollusk species, which includes fingernail clams and a number of snails, available information is severely limited and insufficient to determine environmental impact.

3.8 Plants

Table 9 Organism impact assessment scores for established nonindigenous plants in the Great Lakes basin.

Scientific Name	Common Name	Family	Environmental		Socio-Economic		Beneficial	
			Score	# Unknown	Score	# Unknown	Score	# Unknown
Agrostis gigantea	Redtop, black bent, water bentgrass	Poaceae	Unknown		Low		Unknown	
			0	4	0	0	1	2
Alnus glutinosa	Black alder	Betulaceae	Moderate		Low		Unknown	
			2	1	0	0	1	2
Alopecurus geniculatus	water foxtail, marsh meadow-foxtail	Poaceae	Unknown		Low		Low	
			1	3	0	0	0	0
Butomus umbellatus	flowering rush	Butomaceae	Moderate		Unknown		Unknown	
			3	1	1	2	1	1
Cabomba caroliniana	Carolina fanwort	Cabombaceae	Moderate		Moderate		Unknown	
			4	0	4	0	1	1
Carex acutiformis	Swamp sedge	Cyperaceae	Moderate		Low		Low	
			2	2	0	0	0	0
Carex disticha	Sedge	Cyperaceae	Low		Low		Low	
			1	0	0	0	0	0
Chenopodium glaucum	Oak-leaved goosefoot	Chenopodiaceae	Unknown		Low		Low	
			0	2	0	0	0	1
Cirsium palustre	marsh thistle	Asteraceae	Moderate		Low		Low	
			2	1	0	0	1	0
Conium maculatum	Poison hemlock	Apiaceae	Moderate		Moderate		Low	
			2	0	2	0	1	0
Echinochloa crus-galli	Barnyard grass	Poaceae	Moderate		High		Moderate	
			2	2	6	0	3	0
Epilobium hirsutum	Great hairy willow herb	Onagraceae	Moderate		Low		Low	
			2	1	0	0	1	0
Frangula alnus	Glossy buckthorn	Rhamnaceae	High		Low		Moderate	
			13	2	0	0	2	0
Glyceria maxima	Reed mannagrass	Poaceae	Moderate		Low		Low	
			3	2	0	0	1	0
Hydrocharis morsus-ranae	European frogbit	Hydrocharitaceae	Moderate		Moderate		Low	
			3	2	3	0	1	0
Impatiens glandulifera	Ornamental jewelweed	Balsaminaceae	Unknown		Low		Low	
			1	2	0	0	1	0
Iris pseudacorus	Yellow iris	Iridaceae	High		Moderate		Moderate	
			8	3	3	0	2	1
Juncus compressus	Flattened rush	Juncaceae	Moderate		Low		Low	
			2	2	1	0	1	0
Juncus gerardii	Black-grass rush	Juncaceae	Moderate		Low		Low	
			2	2	1	0	1	0
Juncus inflexus	European meadow rush	Juncaceae	Moderate		Low		Low	
			2	1	1	0	1	0
Lupinus polyphyllus	Lupine	Fabaceae	Unknown		Low		Moderate	
			1	2	1	0	2	0
Lycopus asper	Western water horehound	Lamiaceae	Unknown		Low		Low	
			0	2	0	0	0	0
Lycopus europaeus	European water horehound	Lamiaceae	Unknown		Low		Low	
			1	3	0	0	1	0
Lysimachia nummularia	Moneywort	Primulaceae	Unknown		Low		Low	
			1	3	0	0	1	0

Lysimachia vulgaris	Yellow loosestrife	Primulaceae	Moderate	2	3	Low	0	0	Low	1	0
Lythrum salicaria	purple loosestrife	Lythraceae	High	9	0	Low	0	0	Unknown	1	1
Marsilea quadrifolia	European water clover	Marsileaceae	Unknown	0	4	Low	0	0	Low	1	0
Mentha aquatica	Watermint	Lamiaceae	Unknown	1	5	Low	0	0	Low	1	0
Mentha gracilis	Gingermint	Lamiaceae	Unknown	0	5	Low	0	1	High	13	1
Mentha spicata	Spearmint	Lamiaceae	Unknown	0	6	Low	0	0	High	20	0
Myosotis scorpioides	True forget-me-not	Boraginaceae	Unknown	0	2	Low	0	0	Low	1	0
Myosoton aquaticum	Water chickweed	Caryophyllaceae	Unknown	0	2	Low	0	0	Low	0	0
Myriophyllum spicatum	Eurasian watermilfoil	Haloragaceae	High	6	0	High	10	0	Moderate	2	0
Najas marina	Spiny naiad	Najadaceae	Unknown	0	3	Low	1	0	Low	1	0
Najas minor	Brittle waternymph	Najadaceae	Moderate	3	1	Moderate	2	0	Low	1	1
Nasturtium officinale	watercress	Brassicaceae	Unknown	1	3	Low	1	0	Moderate	4	0
Nymphoides peltata	Yellow floating-heart	Menyanthaceae	Moderate	4	1	Low	1	0	Moderate	2	0
Pluchea odorata odorata	sweetscent	Asteraceae	Unknown	1	5	Low	0	0	Low	1	0
Pluchea odorata succulenta	Marsh fleabane	Asteraceae	Unknown	1	4	Low	0	0	Low	1	0
Poa trivalis	rough-stalked meadow grass	Poaceae	Low	0	1	Low	0	0	Low	1	0
Polygonum persicaria	Spotted knapweed	Polygonaceae	Unknown	1	2	High	6	0	Moderate	2	0
Potamogeton crispus	Curlyleaf pondweed	Potamogetonaceae	Moderate	5	0	Moderate	4	1	Moderate	3	0
Puccinellia distans	reflexed salt grass	Poaceae	Low	0	1	Low	0	0	Moderate	2	0
Rorippa sylvestris	creeping yellow cress	Brassicaceae	Unknown	1	3	Low	1	0	Low	0	0
Rumex longifolius	Yard dock	Polygonaceae	Unknown	1	2	Unknown	1	1	Low	0	0
Rumex obtusifolius	Bitter dock	Polygonaceae	Unknown	1	2	Unknown	1	1	Low	0	0
Salix alba	White willow	Salicaceae	Unknown	0	6	Low	1	0	High	9	0
Salix fragilis	Crack willow	Salicaceae	Unknown	1	5	Moderate	2	0	Moderate	2	0
Salix purpurea	Purple willow	Salicaceae	Unknown	0	5	Low	0	0	Moderate	2	0
Solanum dulcamara	Bittersweet nightshade	Solanaceae	Moderate	2	2	Moderate	2	0	Low	1	0
Solidago semperviren	Seaside goldenrod	Asteraceae	Unknown	1	4	Low	0	0	Low	0	0
Sparganium glomeratum	Bur reed	Sparganiaceae	Unknown	0	6	Low	0	0	Low	0	1
Trapa natans	Water chestnut	Trapaceae	Moderate	5	0	High	8	0	Moderate	3	1
Typha angustifolia	Narrow-leaved cattail	Typhaceae	High	8	0	Low	0	0	High	7	0
Veronica beccabunga	European brooklime	Scrophulariaceae	Unknown	3	3	Low	0	0	Low	0	0

Available information on 28 of the 55 nonindigenous plant species (~ 50%) was insufficient to determine the environmental impact. Especially lacking is information on interactions between nonindigenous plants and native consumers as well as potential to hybridize with native species. Of the species for which all three assessments were completed, only two (7%) – *Carex disticha* and *Poa trivialis* – were assessed as having low environmental, socioeconomic, AND beneficial impact.

Myriophyllum spicatum leads the list of worst invasive plants having both significant environmental and socioeconomic impacts. Other species with high environmental OR socioeconomic impacts (without equivalent or higher offsetting benefits) include *Echinochloa crus-galli*, *Frangula alnus*, *Iris pseudacorus*, *Lythrum salicaria*, *Polygonum persicaria,* and *Trapa natans*. *Typha angustifolia* stands out as the only nonindigenous plant species to have both high beneficial and high environmental impact.

Three species – *Mentha gracilis, Mentha spicata,* and *Salix alba* – have high benefits and low negative socioeconomic impact. Unfortunately, the available information was insufficient to assess the environmental impact of any of these three. Other nonindigenous plants species with moderate benefits and no known offsetting negative impacts include *Lupinus polyphyllus, Nasturtium officinale, Puccinellia distans*, and *Salix purpurea*. More information on environmental impacts is needed for most of these species.

A large set of species have moderate environmental and/or socioeconomic impacts along with low benefits – these include: *Carex acutiformis, Cirsium palustre, Conium maculatum, Epilobium hirsutum, Glyceria maxima, Hydrocharis morsus-ranae, Juncus compressus, Juncus gerardii, Juncus inflexus, Lysimachia vulgaris, Nymphoides peltata*, and *Solanum dulcamara*. One species – *Puccinellia distans* – scored as having moderate environmental, socioeconomic, AND beneficial impacts.

3.9 Algae

Table 10 Organism impact assessment scores for established nonindigenous algae in the Great Lakes basin.

Scientific Name	Common Name	Family	Environmental		Socio-Economic		Beneficial	
			Score	# Unknown	Score	# Unknown	Score	# Unknown
Actinocyclus normanii fo. *subsalsa*	Diatom	Hemidiscaceae	Moderate		Low		Low	
			2	0	1	0	1	0
Bangia atropurpurea	Red alga	Bangiaceae	Unknown		Low		Low	
			1	2	0	1	0	0
Chaetoceros muelleri	Diatom	Chaetocerotaceae	Low		Low		Low	
			0	0	0	0	0	0
Chroodactylon ramosum	Red alga	Stylonemataceae	Low		Low		Low	
			0	0	0	0	0	0
Cyclotella atomus	Diatom	Stephanodiscaceae	Low		Low		Low	
			0	1	0	0	1	0
Cyclotella cryptica	Diatom	Stephanodiscaceae	Low		Low		Low	
			0	0	0	0	1	0
Cyclotella pseudostelligera	Diatom	Stephanodiscaceae	Low		Low		Low	
			0	0	0	0	1	0
Cylindrospermopsis raciborskii	Cylindro	Nostacaceae	Low		Moderate		Low	
			1	0	2	0	0	0
Diatoma ehrenbergii	Diatom	Fragilariaceae	Low		Low		Low	
			0	0	0	0	0	0

Discostella woltereckii	Diatom	Stephanodiscaceae	Low	0	0	Low	0	1	Low	0	0
Enteromorpha flexuosa subsp. *flexuosa*	Grass kelp	Ulvaceae	Moderate	2	0	Moderate	3	0	Moderate	2	0
Enteromorpha intestinalis	Grass kelp	Ulvaceae	Moderate	2	0	Low	1	0	Low	0	0
Enteromorpha prolifera	Grass kelp	Ulvaceae	Low	1	0	Low	1	0	Low	0	0
Hymenomonas roseola	Coccolithophorid	Hymenomonadaceae	Unknown	0	3	Low	0	0	Low	0	0
Nitellopsis obtusa	Starry stonewort	Characeae	Moderate	4	0	High	7	1	Low	1	0
Pleurosira laevis	Diatom	Biddulphiaceae	Unknown	0	2	Low	0	0	Low	0	1
Skeletonema potamos	Diatom	Skeletonemataceae	Low	0	1	Low	0	0	Low	1	0
Skeletonema subsalsum	Diatom	Skeletonemataceae	Low	0	0	Low	0	0	Low	0	0
Sphacelaria fluviatilis	Brown alga	Sphacelariaceae	Low	0	0	Low	0	0	Low	0	0
Sphacelaria lacustris	Brown alga	Sphacelariaceae	Low	0	0	Low	0	0	Low	0	0
Stephanodiscus binderanus	Diatom	Stephanodiscaceae	Low	1	0	Moderate	4	0	Low	1	0
Stephanodiscus subtilis	Diatom	Stephanodiscaceae	Low	0	1	Low	0	0	Low	0	1
Thalassiosira baltica	Diatom	Thalassiosiraceae	Low	0	1	Low	0	0	Low	0	0
Thalassiosira guillardii	Diatom	Thalassiosiraceae	Low	0	0	Low	0	0	Low	0	0
Thalassiosira lacustris	Diatom	Thalassiosiraceae	Low	0	0	Low	0	0	Low	0	0
Thalassiosira pseudonana	Diatom	Thalassiosiraceae	Low	0	0	Low	0	0	Low	1	0
Thalassiosira weissflogii	Diatom	Thalassiosiraceae	Low	0	0	Low	0	0	Low	1	0

Information on algae impacts was surprisingly readily available. Information insufficient to determine environmental impact for only three of the algae species, and all species were able to be assessed for socio-economic and beneficial impacts. More information is needed on competition to assess these remaining species.

No algae species were assessed as having high environmental impacts. Four species of algae – *Actinocyclus normanii, Nitellopsis obtusa, Enteromorpha flexuosa,* and *Enteromorpha intestinalis* were assessed as having moderate environmental impacts. All of these species have significantly impacted water quality outside the Great Lakes and have had measureable localized effects on water quality in the Great Lakes.

Nitellopsis obtusa has high socio-economic impact in the Great Lakes (widespread inhibition of recreational activities). Three additional species were assessed to have moderate socio-economic impact – *Stephanodiscus binderanus, Enteromorpha flexuosa*, and *Cylindrospermopsis raciborskii*. Only *Enteromorpha flexuosa* was assessed as having a (moderate) offsetting beneficial impact.

3.10 Amoebae

Table 11 Organism impact assessment scores for established nonindigenous testate amoebae in the Great Lakes basin.

Scientific Name	Common Name	Family	Environmental		Socio-Economic		Beneficial	
			Score	# Unknown	Score	# Unknown	Score	# Unknown
Psammonobiotus communis			Unknown		Low		Low	
			0	3	0	0	0	0
Psammonobiotus dziwnowi			Unknown		Low		Low	
			0	3	0	0	0	0
Psammonobiotus linearis			Unknown		Low		Low	
			0	0	0	0	0	0

Three species of testate amoebae have recently been identified that are believed to be nonindigenous to the Great Lakes. These species are expected to have low socio-economic impact and no beneficial impact, but information is insufficient to assess their environmental impact.

3.11 Parasites & Diseases

Table 12 Organism impact assessment scores for established nonindigenous parasites and diseases in the Great Lakes basin.

Scientific Name	Common Name	Family	Environmental		Socio-Economic		Beneficial	
			Score	# Unknown	Score	# Unknown	Score	# Unknown
Aeromonas salmonicida	furunculosis	Pseudomonadaceae	Low		Low		Low	
			1	0	1	0	0	0
Piscirickettsia cf. *salmonis*	Muskie pox		Moderate		Low		Low	
			2	0	1	0	0	0
Renibacterium (Corynebacterium) salmoninarum	BKD	Corynebacteriaceae	High		High		Low	
			6	0	12	0	0	0
Bothriocephalus acheilognathi	Asian tapeworm		Low		Low		Low	
			1	0	1	0	0	0
Dactylogyrus amphibothrium	fluke	Dactylogyridae	Low		Low		Low	
			0	0	0	0	0	0
Dactylogyrus hemiamphibothrium	fluke	Dactylogyridae	Low		Low		Low	
			0	0	0	0	0	0
Dugesia polychroa	flatworm	Planariidae	Low		Low		Low	
			0	0	0	0	1	0
Ichthyocotylurus pileatus	fluke		High		Low		Low	
			6	0	0	0	0	0
Neascus brevicaudatus	fluke	Diplostomatidae	Low		Low		Low	
			0	0	0	0	0	0
Scolex pleuronectis	cestode		Low		Low		Low	
			0	0	0	0	0	0
Timoniella sp.	fluke	Acanthostomatidae	Low		Low		Low	
			0	0	0	0	0	0
Acineta nitocrae	Suctorian ciliate	Acinetidae	Low		Low		Low	
			0	0	0	0	0	0
Glugea hertwigi	microsporidean	Glugeidae	Low		Low		Low	
			0	0	0	0	0	0
Heterosporis sp.	Microsporidean		High		Low		Low	
			7	0	0	0	0	0
Myxobolus cerebralis	Whirling disease	Myxosomatidae	High		Low		Low	
			7	0	1	0	0	0

Sphaeromyxa sevastopoli	Myxosporean		Low		Low		Low	
			0	0	0	0	0	0
Trypanosoma acerinae	flagellate		Low		Low		Low	
			0	0	0	0	0	0
Novirhabdovirus sp.	Viral Hemorrhagic Septicemia (VHS)	Novirhabdoviridae	High		High		Low	
			7	0	7	0	0	0
Ranavirus sp.	LMBV	Iridoviridae	High		Low		Low	
			6	0	0	0	0	0
Rhabdovirus carpio	SVC		High		Low		Low	
			6	0	1	0	0	0

All AIS assessed in this category are parasites/disease of fish. Information on parasites and diseases is relatively good – for no species was the information insufficient to complete an assessment. As might be anticipated, all of these species are assessed as having low benefit. Surprisingly, only two (10%) of the species– viral hemorrhagic septicemia (VHS) and bacterial kidney disease (BKD) - were assessed as having significant (high) socio-economic impact. Many additional species in this category (40%) were assessed as having significant environmental impacts. High impact parasites/diseases include VHS and BKD as well as whirling disease, large mouth bass virus, spring viremia of carp, Heterosporis, and the fluke *Icthyocotylurus pileatus*. Muskie pox was assessed as having moderate environmental impact.

4. DISCUSSION

The impact assessment was applied to 182 established nonindigenous species. The state of scientific knowledge for nearly half (49%) of these species is insufficient to assess the overall environmental impact. Of those 93 species where knowledge was sufficient to support environmental impact assessment, 25 species (27%) have had a high impact, 32 species (34%) have had a moderate impact, and 37 species (40%) were considered low impact. Species that had high environmental impact included eight fishes (alewife, common carp, white perch, round goby, rainbow trout, rainbow smelt, sea lamprey, and brown trout), two crustaceans (spiny waterflea and fishhook waterflea), three mollusks (zebra mussel, quagga mussel, and faucet snail), five plants (glossy buckthorn, yellow flag iris, purple loosestrife, Eurasian watermilfoil, and narrow-leaved cattail), and seven parasites/diseases (VHS, LMBV, SVC, BKD, whirling disease, *Heterosporis* and *Ichthyocotylurus pileatus*). Our findings suggest that often quoted figures such as 'only 10% of nonindigenous species become invasive' significantly underestimate environmental impact. Even taking a conservative approach and assuming all the unassessed species will prove to have negligible impact, at LEAST 13% of established nonindigenous species in the Great Lakes have significant environmental impact.

Relative to environmental impact, many fewer species were assessed as having unknown socio-economic impacts and/or beneficial effects. In the latter two sub-assessments, many species lacked any evidence to suggest that the species could have a known or unknown significant impact. Thirteen species (7%) lacked sufficient knowledge to fully assess the socio-economic impacts, with necessary knowledge most often limited with regard to recreational threats and decreased water quality. More than three quarters of the assessed species (85%) were assessed as having little or no socio-economic impact, while 14 species (8%) and 12 species (7%) had a moderate or high socio-economic impact, respectively. Species that had high socio-economic impact included three fishes (alewife, round goby, and sea lamprey), two mollusks (zebra and quagga mussels), four plants (barnyard grass, Eurasian watermilfoil, spotted knapweed, and water chestnut), one alga (starry stonewort), and two diseases (BKD and VHS).

The distribution of beneficial effects was similar to the pattern seen in socio-economic impacts. We were unable to assess beneficial effect for 15 species (8%) due to insufficient scientific knowledge. Of the remaining species, 12 species (7%) have had a high beneficial effect, 17 species (10%) have had a moderate beneficial effect, and 139 species (83%) have had little or no beneficial effect. Fishes and plants were the only taxonomic groups to contain species with high beneficial effects, which largely resulted from their direct recreational and commercial value. Of the eight highly beneficial fish species, six (alewife, common carp, white perch, rainbow trout, rainbow smelt, and brown trout) were also characterized as having high environmental impacts. The two remaining highly beneficial fish species (coho salmon and Chinook salmon) were assessed as having moderate environmental impacts. Narrow leaved cattail was also assessed as having high (negative) environmental impacts in addition to its high benefits. The environmental impact of the remaining three highly beneficial plants (gingermint, spearmint, and white willow) could not be assessed.

To our knowledge, no formal environmental and socio-economic impact assessment of all established non-indigenous species in the Great Lakes has been completed prior to this effort, although certain species have been qualitatively identified as high-impact invaders (see Great Lakes ANS risk assessments summarized by Dupre 2011). For instance, Mills et al. (1993) identified nine nonindigenous fauna that have had “substantial impacts” on the ecology or economy of the Great Lakes region, including six species identified with a high environmental impact in our assessment (sea lamprey, alewife, common carp, brown trout, white perch, and zebra mussel) and three species identified with a moderate environmental impact (chinook salmon, coho salmon, and ruffe). The Great Lakes Panel on Aquatic Nuisance Species (GLPANS 2005) also relied on expert judgement to generate a list of harmful, high-priority nonnative species, including several recent invaders unmentioned by Mills et al. (1993). Even some of the more comprehensive recent risk assessments of Great Lakes ANS have been either limited to those species for which sufficient data were available to run ecological niche models (USEPA 2008) or to those with the potential to disperse beyond the Great Lakes basin (USACE 2011). In each case, either a lack of methodological transparency or systematic implementation has restricted our ability to compare our findings directly to these previous studies. On a qualitative basis, our assessment is consistent in identifying as high-to-moderate risk those species called out by the previous studies.

Table 13 Summary of impact assessment results by taxonomic group. For each impact category (i.e. environmental, socio-economic, beneficial), the number of species whose impact was assessed as high (H), moderate (M), low (L), or unknown (U) is given. Note: “Arthropods” refers to non-crustacean arthropods.

	Environmental				**Socio-Economic**				**Beneficial**			
Taxon	**H**	**M**	**L**	**U**	**H**	**M**	**L**	**U**	**H**	**M**	**L**	**U**
Fishes (n=28)	8	5	1	14	3	1	20	4	8	2	13	5
Annelids (n=6)	0	0	0	6	0	0	6	0	0	0	5	1
Arthropods (n=2)	0	0	0	2	0	0	2	0	0	1	1	0
Bryozoans (n=1)	0	0	0	1	0	0	0	1	0	0	1	0
Coelenterates (n=2)	0	0	0	2	0	0	1	1	0	0	2	0

Crustaceans (n=20)	2	1	0	17	0	0	18	2	0	0	19	1
Mollusks (n=18)	3	2	1	12	2	2	11	3	0	0	16	2
Plants (n=55)	5	19	3	28	4	8	40	3	4	13	33	5
Algae (n=27)	0	4	20	3	1	3	23	0	0	1	26	0
Amoebae (n=3)	0	0	0	3	0	0	3	0	0	0	3	0
Parasites and Diseases (n=20)	7	1	12	0	2	0	18	0	0	0	20	0
Total	25	32	37	88	12	14	142	14	12	17	139	14

Our results reflect a need for additional research on the environmental impacts of many Great Lakes nonindigenous species – especially benthic species other than mollusks (impacts of annelids, non-crustacean arthropods, bryozoa, coelenterates, and amoeba are all unknown). Each of these taxonomic groups is represented by only a few species, which may reflect a lack of study of the group rather than a true lack of invasion. High impact species are taxonomically diverse – with all taxonomic groups represented except for the above, under-studied groups (which might reasonably be expected to be included if more information was available).

At least 31% of the nonindigenous species found in the Great Lakes have significant (moderate to high) environmental impact. While substantially higher than the oft-cited estimate of '10% of established nonindigenous species have significant impacts' this estimate is likely also an under-estimate of the true environmental impact. If the 88 currently unassessed species follow the trends of the assessed species this number will be closer to 60%. While less substantial, socio-economic impacts are also likely higher than the 10% figure – we estimate between 14 and 16% of the nonindigenous species found in the Great Lakes have moderate to high socioeconomic impact.

Of the 29 species assessed as having significant (moderate to high) benefits, only one – *Puccinellia distans* – was assessed as having low environmental and socio-economic impacts. Eight of the beneficial species (28%) could not be adequately assessed, but the remaining 20 species (70%) had significant negative environmental and/or socioeconomic impacts.

Nonindigenous aquatic fauna have had significant, documented impacts in the Great Lakes, but our results suggest that known impacts are far fewer than those that remain to be investigated. Prior to this study, available information about these impacts had not been organized and compared across all nonindigenous fauna in the Great Lakes. Our research has resulted in the collection, synthesis, and analysis of the available scientific knowledge on the impacts of ANS in the Great Lakes. The impact assessment results and corresponding literature reviews will not only inform scientists, managers, and policymakers about the impacts currently occurring in the Great Lakes, but will facilitate the prioritization of future goals and efforts. Furthermore, the publication of these products complements all other Great Lakes ANS information currently contained in GLANSIS and strengthens the role of GLANSIS as the primary reporting site for ANS in the Great Lakes.

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APPENDIX A. ORGANISM IMPACT ASSESSMENTS

Individual impact assessments for all established nonindigenous fauna are presented by taxonomic group. For each species, all six criteria in each impact category were answered as accurately as possible using available information on current and historical impacts. For all criteria assessed as highly or moderately significant (score of ‘6’ or ‘1’, respectively), evidence used to make the assessment is referenced below the response.

A.1 Fishes

Scientific Name: *Alosa aestivalis*
Common Name: Blueback herring

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

- *If blueback herring became established throughout Lake Ontario and/or spread to other Great Lakes it could impede recovery of depressed populations of native fishes such as cisco and lake trout (Owens et al. 1998). There is also speculation that blueback herring could displace rainbow smelt and/or native forage fishes (Marsden and Hauser 2009).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population	1

AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	
Not significantly	0
Unknown	U √

- *If blueback herring became established throughout Lake Ontario and/or spread to other Great Lakes it could impede recovery of depressed populations of native fishes such as cisco and lake trout (Owens et al. 1998). There is also speculation that blueback herring could displace rainbow smelt and/or native forage fishes (Marsden and Hauser 2009).*
- *The introduction of blueback herring into Theo Reservoir in Briscoe County, Texas resulted in the elimination of large-bodied zooplankton; the community shifted from cladoceran to copepod dominance (Guest and Drenner 1991).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**3**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or	6

tourism	
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

- *One study in headwater lakes of Massachusetts indicates that this is a beneficial prey item for largemouth bass (*Micropterus salmoides*) introduced near the blueback's native range (Yako and Mather 2000).*

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Alosa pseudoharengus*

Common Name: Alewife

Environmental: High
Socio-Economic: High
Beneficial: High

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6 √
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

- *Alewife has been shown to cause thiamine deficiency and, consequently, early mortality syndrome (EMS) in populations of alewife predators. EMS and its adverse effects on recruitment and fish populations is well-documented for coho salmon (*Oncorhynchus kisutch*) (Fitzsimons et al. 1999), lake trout (Fitzsimons et al. 1999), and Atlantic salmon (Ketola et al. 2000, Madenjian et al. 2008a) (in which it is also referred to as Cayuga syndrome (Fitzsimons et al. 1999)), among other fishes.*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6 √
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U

- *Disappearance of native planktivorous salmonids, such as lake whitefish (*Coregonus clupeaformis*), in the Great Lakes has been attributed in part to the introduction of alewife because of reduced zooplankton populations (Crowder and Binkowski 1983, Page and Laird 1993, Todd 1986).*
- *Crowder (1984) speculated that a cisco native to Lake Michigan, the bloater (*C. hoyi*) evolved fewer and shorter gill rakers, and shifted to benthic habitat and diet as a result of competition with alewife.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6 √
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0

Unknown	U

- *Alewife likely has an even larger effect on native fish populations through predation of larvae than competition for food resources (Eck and Wells 1987, Madenjian et al. 2008a). Using time-series data for various fish populations along with change point regression analysis, scientists concluded that predation of larvae by alewife likely contributed to the decline of yellow perch (*Perca flavescens*), deepwater sculpin (*Myoxocephalus thompsonii*), burbot (*Lota lota*), Atlantic salmon (*Salmo salar*), lake trout (*Salvelinus namaycush*), and emerald shiner (*Notropis atherinoides*) (Madenjian et al. 2008a).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**18**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact

>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1√
Not significantly	0
Unknown	U

- *During the 1950s and 60s, dead alewives contributed to oxygen depletion and hypoxia.*

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1√
Not significantly	0
Unknown	U

- *Through predation and EMS effects on lake trout, it has affected commercial fisheries in lower 4 lakes*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6 √
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U

- *Periodic large-scale die-offs littered the beaches of the Great Lakes with rotting fish in the 1960s. Such die-offs caused large-scale beach closures (Becker 1983, Brown 1968).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6 √
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U

- *Alewife mortality events that littered the beaches of the Great Lakes with rotting fish happened with such frequency that they became known as "the annual spring and summer die-off" (Brown 1968).*

Socio-Economic Impact Total	**14**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	**<u>High</u>**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

<u>BENEFICIAL EFFECT</u>

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1√
Not significantly	0
Unknown	U

- *Alewife is extremely important as prey for the salmon and trout fisheries in the Great Lakes.*

These fisheries are both recreational and commercial.

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0
Unknown	U √

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6 √
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U

- *Non-native salmonids in the Great Lakes support a multimillion dollar sport fishing economy and have caused alewife populations to decline to the extent that salmonid stocking has been reduced to bolster alewife abundance and sustain the sport fisheries (Horns 2010, McCrimmon 2002, Murry et al. 2010).*

Beneficial Effect Total	**7**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown

1	≥1	

Scientific Name: *Apeltes quadracus*

Common Name: Fourspine stickleback

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

- *Rapid increases of* A. quadracus *in Thunder Bay suggest that this species is quickly displacing native sticklebacks (Stephenson and Momot 2000).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

- *Rapid increases of* A. quadracus *in Thunder Bay suggest that this species is quickly displacing native sticklebacks (Stephenson and Momot 2000).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6

Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**4**

Scoring		
Score	# U	**Impact**
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

<u>BENEFICIAL EFFECT</u>

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0
Unknown	U √

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6

Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

<table>
<tr><th colspan="3">Scoring</th></tr>
<tr><td>Score</td><td># U</td><td>Impact</td></tr>
<tr><td>>5</td><td>Any</td><td>High</td></tr>
<tr><td>2-5</td><td>Any</td><td>Moderate</td></tr>
<tr><td>0</td><td>0-1</td><td rowspan="2"><u>Low</u></td></tr>
<tr><td>1</td><td>0</td></tr>
<tr><td>0</td><td>≥2</td><td rowspan="2">Unknown</td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

Scientific Name: *Carassius auratus*

Common Name: Goldfish

Negative Environmental: Unknown
Negative Socio-Economic: Low
Beneficial: Unknown

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

- *According to Moyle (1976), goldfish probably compete with native fishes for food and space.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1

Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *Richardson et al. (1995) found that goldfish are benthic herbivores whose behavior often results in visible increases in turbidity and decreases in aquatic vegetation.*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**1**
Total Unknowns (U)	**3**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6

Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0
Unknown	U √

- *It is a common ornamental and pet species (Scott and Crossman 1973). In the United States, large numbers are cultured as bait, as forage for sport fishes, and as young fish that are then sold in the aquarium trade, mostly as live food (i.e. feeder fish) for carnivorous ornamental fishes (Litvak and Mandrak 1993).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0
Unknown	U √

- *It is a common ornamental and pet species (Scott and Crossman 1973). In the United States, large numbers are cultured as bait, as forage for sport fishes, and as young fish that are then sold in the aquarium trade, mostly as live food (i.e. feeder fish) for carnivorous ornamental fishes (Litvak and Mandrak 1993).*

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**2**

Scoring		
Score	# U	**Impact**
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

Scientific Name: *Cyprinus carpio*

Common Name: Common carp

Environmental Impact: High
Socio-Economic Impact: Unknown
Beneficial Effect: High

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

- *Laird and Page (1996) stated that common carp may compete with ecologically similar species such as carpsuckers and buffalos.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

- *There is evidence that common carp prey on the eggs of other fish species (Miller and Beckman 1996, Moyle 1976, Taylor et al. 1984). It may thus be responsible for the decline of the razorback sucker (*Xyrauchen texanus*) in the Colorado River basin (Taylor et al. 1984).*
- *Miller and Beckman (1996) documented white sturgeon (*Acipenser transmontanus*) eggs in the stomachs of common carp in the Columbia River.*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

- Cyprinus carpio *has hybridized with goldfish (*Carassius auratus*) and, in Europe, with the locally native crucian carp (*C. carassius*). However, crucian x common carp hybrids were found in just 3 of 10 populations in which the two species geographically overlapped (Hänfling et al. 2005, Taylor and Mahon 1977).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6 √
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

- *It dislodges plants and roots around in the substrate, which causes a deterioration of habitat for species requiring clean water (Bellrichard 1996, Cahoon 1953, Cole 1905, Laird and Page 1996).*
- *Common carp may destroy aquatic macrophytes directly by uprooting or consuming the plants (Lee et al. 1980 et seq.), or indirectly by increasing turbidity, thereby reducing light for photosynthesis.*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6 √
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

- *Common carp may destroy aquatic macrophytes directly by uprooting or consuming the plants (Lee et al. 1980 et seq.) It dislodges plants and roots around in the substrate, which causes a deterioration of habitat for species requiring vegetation ((Bellrichard 1996, Cahoon 1953, Cole 1905, Laird and Page 1996).*
- *One study analyzed the relationship between common carp biomass, vegetative cover, and waterfowl abundance over time in a shallow inland lake in Illinois and found that an increase in carp biomass from <30 kg/ha to over 250 kg/ha was strongly correlated with a decrease in vegetative cover from its original value of 94% to just 17% (Bajer et al. 2009). Waterfowl activity also dropped to ~10% of its original value (Bajer et al. 2009).*
- *Destruction and depletion of crayfish (*Cambarellus montezumae*) habitat by common carp, particularly of*

algal species and macrophytes, were deemed to be the major mechanism of crayfish decline (Hinojosa-Garro and Zambrano 2004).

Environmental Impact Total	**12**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	**<u>High</u>**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

<u>SOCIO-ECONOMIC IMPACT</u>

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *Common carp has high lipid content, and has been used to test contamination levels in the Great Lakes for comparison to human consumption guidelines. Gewurtz et al. (2010) found that high PCB levels are of concern for both sensitive and general populations, especially in mid-large fish.*

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

- *In a study of 129 lakes in Iowa, a negative relationship was discovered between* C. carpio *abundance and sportsfish abundance (bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), and crappie (*Pomoxis *spp.)) (Jackson et al. 2010). This relationship could be due to the poor water quality (e.g., high nutrient levels and low water clarity), which was also associated with high* C. carpio *abundance; however,* C. carpio*'s role in the decline of the sportsfish populations was not conclusively determined (Jackson et al. 2010).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

Socio-Economic Impact Total	**1**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6

Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6 √
Yes, but its economic contribution is small	1
Not significantly	0
Unknown	U

- Cyprinus carpio *is fished commercially in the Great Lakes by both Canada and U.S. (Brown et al. 1999, Dann and Schroeder 2003).*
- Cyprinus carpio *is commonly used in aquaculture in Mexico and Central America, South America, and Eurasia (FAO 2005a). Global aquaculture production of common carp increased 10.4% per year between 1993 and 2002. At over 33 million tons in 2002, it made up nearly 14% of the global freshwater aquaculture production (FAO 2005a).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1 √
Not significantly	0
Unknown	U

- *According to Scott and Crossman (1973), the recreational pursuit of* C. carpio *was not considered common in Canadian waters historically, although it has been gaining popularity among anglers and in the tourism fisheries and fish markets in the Great Lakes region. Becker (1983) also described the growing presence of* C. carpio *in many branches of Wisconsin's recreational and commercial fisheries.*

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

- *Common carp has high lipid content and has been used to test contamination levels in the Great Lakes for comparison to human consumption guidelines (Gewurtz et al. 2010, Pérez-Fuentetaja et al. 2010).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**8**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	**<u>High</u>**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Enneacanthus gloriosus*

Common Name: Bluespotted sunfish

Environmental: Unknown
Socio-Economic: Low
Beneficial: Unknown

Comments: Only one relevant source was found; statement regarding impact was brief (Hoyer, M.V., and D.E. Canfield, Jr. 1994. Handbook of Common Freshwater Fish in Florida Lakes. University of Florida, Institute of Food and Agricultural Sciences. Publication SP 160.)

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6

Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**6**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0
Unknown	U √

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

Beneficial Effect Total	**0**
Total Unknowns (U)	**2**

<table>
<tr><th colspan="3">Scoring</th></tr>
<tr><td>Score</td><td># U</td><td>Impact</td></tr>
<tr><td>>5</td><td>Any</td><td>High</td></tr>
<tr><td>2-5</td><td>Any</td><td>Moderate</td></tr>
<tr><td>0</td><td>0-1</td><td rowspan="2">Low</td></tr>
<tr><td>1</td><td>0</td></tr>
<tr><td>0</td><td>≥2</td><td rowspan="2"><u>Unknown</u></td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

Scientific Name: *Esox niger*

Common Name: Chain pickerel

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0

Unknown	U

- *Chain pickerel is capable of hybridizing and forming viable offspring with related species, including the redfin pickerel (*Esox americanus*) and northern pike (*E. lucieus*), both present in the Great Lakes basin (Herke et al. 1990, Scott and Crossman 1973). The consequences of this are unknown.*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**1**
Total Unknowns (U)	**4**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6

Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

- *Speculation exists that the predation by chain pickerel could have a negative impact on some sport fishes, particularly native trout and other stocked salmonids (Brokaw 2008). Chain pickerel has been actively controlled in parts of Maine due to its reputation as a voracious feeder (Brokaw 2008).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1 √
Not significantly	0
Unknown	U

- *Chain pickerel a popular sport fish in some parts of the Northeast (especially in the winter). In the Great Lakes and Canada, it is of minor importance to recreational fishing overall, although it is often kept if caught. It is not of commercial importance (Scott and Crossman 1973).*

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**1**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Gambusia affinis*

Common Name: Western mosquitofish

Environmental: Unknown
Socio-Economic: Low
Beneficial: Unknown

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

- *Meffe (1983, 1985) found that mosquitofish are very aggressive, even towards larger fishes; this has led to the decline of many fish species elsewhere in the U.S. (see Courtenay and Meffe 1989, Deacon et al. 1964, Whitmore 1997), although documentation of this sort in the Great Lakes is lacking.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

- *Mosquitofish is known to prey on eggs, larvae, and juveniles of various fishes, including those of largemouth bass (*Micropterus salmoides*) and common carp (*Cyprinus carpio*); it is also known to prey on adults of smaller species (Courtenay and Meffe 1989, Meffe 1985).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline	6

or extinction of one or more native species	
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**4**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus,

bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

- *Mosquitofish is known to prey on eggs, larvae, and juveniles of various fishes, including fish of recreational importance, such as largemouth bass (*Micropterus salmoides*) (Courtenay and Meffe 1989, Meffe 1985).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1

Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1√
Not significantly	0
Unknown	U

- *Anecdotal observations in the early 20th century spurred the reputation of* G. affinis *as a successful control agent of mosquito populations via consumption of their larvae (Pyke 2008). Since these times, many studies on the success of mosquitofish as a mosquito control agent have been completed and have often led to different outcomes (Pyke 2008).*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0
Unknown	U √

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority	1

OR It is potentially important to medicine or research and is currently being or scheduled to be studied	
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

Beneficial Effect Total	**1**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

Scientific Name: *Gymnocephalus cernua*

Common Name: Ruffe

Environmental: Moderate
Socio-Economic: Unknown
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

- *Savino and Kolar (1996) conducted a laboratory study with ruffe and yellow perch (*Perca flavescens*) and found that competition could occur between the two species, but that the outcome was not always clear, as each species exhibited competitive advantages and disadvantages.*
- *Fullerton et al. (1998) concluded that similarities in dietary preferences and feeding rates of ruffe and yellow perch suggest a strong possibility for interspecific competition.*
- *Kolar et al. (2002) found that in a laboratory setting, ruffe exhibited higher consumption rates of benthic invertebrates in darkness over bare cobble and complex substrates than did yellow perch.*
- *The increase in ruffe in western Lake Superior was concurrent with declines in several fish species, including yellow perch (*Perca flavescens*), emerald shiner (*Notropis atherinoides*), and trout-perch (*Percopsis omiscomaycus*) (Bronte 1998, McLean 1993). However, there was a lack of clear causal evidence between the two events (Bronte 1998).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1 √
Not significantly	0

Unknown	U

- *In Lake Superior, consumption of cisco (*Coregonus artedii*) eggs by ruffe has been documented at a level that could impact the population over winter months (Selegby 1998). There has been a great deal of concern that ruffe may have a detrimental effect on more desirable species in Lake Superior, including yellow perch and walleye (*Sander vitreus*), by feeding on the young of these species (Raloff 1992).*
- *In Scotland, native perch populations have declined and, in Russia, whitefish numbers have declined because of egg predation by ruffe (McLean 1993).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**2**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High

2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- *Under a moderate scenario of spread and impact, it was predicted that ruffe could generate costs in excess of $500 million by 2050 (Leigh 1998). However, these concerns have yet to be confirmed as the extent of ruffe's contribution to declines in native fish populations remains undecided (Czypinksi et al. 2007).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

- *When ruffe first invaded Lake Superior, it was thought that this species could generate a considerable cost for recreational fishing, particularly by causing a decline in yellow perch (*Perca flavescens*) populations (Leigh 1998). However, these concerns have yet to be confirmed as the extent of ruffe's contribution to declines in native fish populations remains undecided (Czypinksi et al. 2007).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**3**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Lepisosteus platostomus*

Common Name: Shortnose gar

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

- *Anecdotal evidence has suggested that* Lepisosteus platostomus *may have a negative effect on other fish species, including bluegill (*L. macrochirus*), green sunfish (*L. cyanellus*), young bass, and muskellunge (Becker 1983, Evermann and Goldsborough 1902).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

- *Anecdotal evidence has suggested that* Lepomis platostomus *may have a negative effect on other fish species, including bluegill (*L. macrochirus*), green sunfish (*L. cyanellus*), young bass, and muskellunge (Becker 1983, Evermann and Goldsborough 1902).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline	6

or extinction of one or more native species	
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**4**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

- *Due to its high abundance and perceived nuisance, it was actively controlled in Lake Chautauqua, NY in the late 1890s (Evermann and Goldsborough 1902). Shortnose gar may adversely affect recreationally important fishes (e.g., young bass and muskellunge (*Esox masquinongy*)) (Evermann and Goldsborough 1902).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1

Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

- *Becker (1983) suggested that* L. platostomus *could contribute to a balanced fish community*.

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Lepomis humilis*

Common Name: Orangespotted sunfish

Environmental: Unknown
Socio-Economic: Low
Beneficial: Unknown

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

- *It is possible that the orangespotted sunfish competes for food with native fishes such as young bass (*Micropterus *spp.), bluegill (*Lepomis macrochirus*), and crappie (*Pomoxis *spp.) (Cross 1967).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR	1

It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**5**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6

Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

- *It is possible that the orangespotted sunfish competes for food with native fishes such as young bass (*Micropterus *spp.), bluegill (*Lepomis macrochirus*), and crappie (*Pomoxis *spp.) (Cross 1967).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0
Unknown	U √

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0
Unknown	U √

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or	6

native species	
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**2**

Scoring		
Score	# U	**Impact**
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

Scientific Name: *Lepomis microlophus*

Common Name: Redear sunfish

Environmental: Moderate
Socio-Economic: Low
Beneficial: Moderate

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

- *In inland lakes of southern Michigan, introduced redear is associated with ecological changes in populations of pumpkinseed (*L. gibbosus*), a native molluscivore. Effects of introduced redear sunfish on pumpkinseed include reduced consumption of snails by pumpkinseed and reduced population densities (Huckins 1997). When introduced into a waterbody, Huckins et al. (2000) found that competition between redear sunfish and pumpkinseed resulted in a 56% reduction in pumpkinseed abundance and a 69% reduction in average snail biomass when compared with lakes without redear sunfish.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

- *Direct impacts on invertebrates and indirect impacts on vegetation are associated with* L. microlophus *in Tennessee (Ruiz et al. 1999). Mollusk predation by* L. microlophus*, particularly on gastropods, can result in reduced grazing activity, changes in periphyton abundance and community structure, and a shift towards phytoplankton-dominated (rather than macrophyte) communities (Martin et al. 1992, McCollum et* *al. 1998).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *Mollusk predation, particularly on gastropods, can result in reduced grazing activity, changes in periphyton abundance and community structure, and a shift towards phytoplankton-dominated (rather than macrophyte) communities (McCollum et al. 1998, Martin et al. 1992).*

Environmental Impact Total	**2**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low

1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

- *Although redear sunfish is a molluscivore, it is not suitable as a biocontrol agent for zebra mussels; experimentally, it significantly prefers gastropods over zebra mussels (French and Morgan 1995).*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1 √
Not significantly	0
Unknown	U

- *Redear sunfish was intentionally introduced into inland lakes of Michigan to enhance recreational fisheries*

(Huckins et al. 2000).

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1√
Not significantly	0
Unknown	U

- *Redear sunfish has been used as a research organism to measure uptake levels of chemicals and toxins in other parts of the U.S. (e.g., Bettoli and Clark 1992, Campbell 1994, Eller 1969, Ghent and Grinstead 1965, Melwani et al.2009, Pickhardt et al. 2006, Saiki et al. 2005, Sorensen 1988).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**2**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**<u>Moderate</u>**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Misgurnus anguillicaudatus*

Common Name: Oriental weatherfish

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

- *There is concern that if* M. anguillicaudatus *becomes more abundant and spreads, it will reduce populations of aquatic insects important as food to native fishes (Page and Laird 1993).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR	1

It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- *Experimentation in Australia on the environmental impacts of oriental weatherfish suggests that this species may significantly increase turbidity and nitrogen levels in standing water (Keller and Lake 2007).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**5**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- *Experimentation in Australia on the environmental impacts of oriental weatherfish suggests that this species may significantly reduce macroinvertebrate abundance and increase turbidity and nitrogen levels in standing water (Keller and Lake 2007).*

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0
Unknown	U √

- *In addition to appearing in the aquarium trade,* M. anguillicaudatus *has been introduced into several parts of the world for aquaculture purposes and as a bait fish; however, the occurrence of such use in the Great Lakes is not currently known (Welcomme 1988).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1

Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Morone americana*

Common Name: White perch

Environmental: High
Socio-Economic: Moderate
Beneficial: High

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6 √
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U

- *Parrish and Margraf (1990) hypothesized that white perch competes with native yellow perch (*Perca flavescens*) for zooplankton. They determined that growth rates of yellow perch had declined since the invasion of white perch in Lake Erie, especially in the western basin. They also determined that the two species had considerable diet overlap and found that white perch consumed 27 percent more food than yellow perch in one sample.*
- *It has been speculated that competition between white perch and forage fishes, such as emerald shiner (*Notropis atherinoides*) and spottail shiner (*N. hudsonius*), as well as freshwater drum (*Aplodinotus grunniens*), is complex and may be responsible for the declines of the latter species (Parrish and Margraf 1994, Stapanian et al. 2007).*
- *Within three years of being introduced into a Nebraska reservoir, white perch had completely replaced the previously dominant black bullhead (*Ameiurus melas*) (Hergenrader and Bliss 1971).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6 √
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0

Unknown	U

- *Walleye (*Sander vitreus*) or white bass (*Morone chrysops*) eggs can make up 100% of white perch diet depending on which fish is spawning. During a three-year study, this diet was found to be unique in that: 1) eggs were eaten for a comparatively long time; 2) they were the only significant food item eaten by adults during two of the three years; 3) large volumes were eaten per individual; and, 4) most fish were feeding. White perch also feeds heavily on minnows (*Notropis *spp.) (Schaeffer and Margraf 1987).*
- *Madenjian et al. (2000) hypothesized that egg predation by white perch was the most significant contributor to the large decline in white bass recruitment in Lake Erie in the 1980s.*
- *It has been speculated that a white perch diet of Daphnia in Lake Champlain contributed to the decline of the species in this locality since white perch became established (Couture and Watzin 2008).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6 √
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

- *White perch is known to hybridize with native white bass (*Morone chrysops*), in western Lake Erie and in Ohio and Michigan waters (Todd 1986). Hybrids have also been reported from the Detroit River and the St. Clair River in Michigan (Todd 1986). Because these hybrids are capable of backcrossing with the parental species, and possibly producing of F2 hybrids by crossing amongst themselves (Todd 1986), they dilute the gene pool of each parent species.*
- *Hybrids of* M. americana *and* M. mississippiensis *were first found in 2000 in the middle Illinois River (Irons et al. 2002). Hybridization and competition may represent another threat to the already dwindling yellow bass of that region.*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0√

Unknown	U

Environmental Impact Total	**18**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small	1√

AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U

- *The collapse of the walleye fishery in the Bay of Quinte (on the north shore of Lake Ontario) coincided with an increase in the white perch population and may have been a result of egg predation and lack of recruitment (Schaeffer and Margraf 1987).*
- *Other recreationally/commercially important species, such as white bass (*Morone chrysops*), yellow perch (*Perca flavescens*), and species of forage fish are likely negatively affected by white perch through competition, egg predation, or hybridization (see above).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

- *Other recreationally/commercially important species, such as white bass (*Morone chrysops*), yellow perch (*Perca flavescens*), and species of forage fish are likely negatively affected by white perch through competition, egg predation, or hybridization (see above).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

Socio-Economic Impact Total	**2**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1

Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6 √
Yes, but its economic contribution is small	1
Not significantly	0
Unknown	U

- *As of 2003, it was estimated that over 500,000 lbs. of white perch are caught commercially in the U.S. and Canada each year (188,000+ lbs. in the U.S. alone), particularly in Lakes Erie and Ontario (Brown et al. 1999, Dann and Schroeder 2003). This provides an estimated value of approximately \$107,000 yr^{-1} in the U.S. and \$260,000 yr^{-1} overall (Dann and Schroeder 2003).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1 √
Not significantly	0
Unknown	U

- *While white perch is a good food fish and could potentially be pursued recreationally, it is not as commonly exploited as a game fish (Scott and Crossman 1973). In some Great Lakes states, catch of white perch is allowed but is largely prohibited otherwise (GLPANS 2008).*

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**7**

Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Neogobius melanostomus*

Common Name: Round goby

Environmental: High
Socio-Economic: High
Beneficial: Low

Comments: Round gobies are one of the only significant predators of *Dreissenid* mussels, and thus help to fill a gap in the food web; however, it is estimated that they only consume about 1% of the standing population (Johnson et al. 2005)

There is speculation that predation on benthic mussels reduces potential habitat for microorganisms or other species (Lederer et al. 2006), although the extent of round goby impact on substrate type along the lake bottom is unknown.

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *Round goby, via predation on zebra mussel, likely has the ability to facilitate the bioaccumulation of contaminants up the food chain to benthic-oriented piscivores that feed on round goby, although experimental results with various contaminants vary (Hogan et al. 2007, Morrison et al. 2000, Ng et al. 2008).*
- Neogobius melanostomus *introductions may also be a vector for the spread of avian botulism. The change in behavior of infected* N. melanostomus *may make them preferred prey items to piscivorous birds (Yule et al. 2006). In Lake Erie, botulism infected birds had been feeding more on round goby compared to uninfected birds (Corkum et al. 2004).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6 √
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U

- *It competes with rainbow darter (*Etheostoma caeruleum*), logperch (*Percina caprodes*), and the endangered northern madtom (*Noturus stigmosus*) for small macroinvertebrates (French and Jude 2001).*
- *Shelters inhabited by round goby are similar to those of log perch, and in experiments, round goby was a more aggressive and successful competitor for this limited space, regardless of which species had prior residence of the habitat (Balshine et al. 2005).*
- *Mottled sculpin (*Cottus bairdii*) has been particularly affected since the establishment of* N. melanostomus *(Marsden and Jude 1995). This is almost certainly due to competition from large round goby (greater than 100 mm) for spawning sites, from medium round goby (60-100 mm) for space, and from small round goby*

(less than 60 mm) for food (Janssen and Jude 2001).

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6 √
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U

- *In a study of Lake Erie tributaries in New York, caddisflies and mayflies were better represented in terms of abundance and taxa number, respectively, in streams without round goby, indicating that the goby's consumptive behavior has had an impact on invertebrate communities in this area (Krakowiak and Pennuto 2008).*
- *The numbers of native fish species have declined in areas where the round goby has become abundant (Crossman et al. 1992). In laboratory experiments, this species has been found to prey on darters and other small fish, as well as lake trout (*Salvelinus namaycush*) eggs and fry.*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild	1

AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U √

Environmental Impact Total	**13**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	<u>**High**</u>
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

<u>**SOCIO-ECONOMIC IMPACT**</u>

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *Round goby, via predation on zebra mussel, likely has the ability to facilitate the bioaccumulation of contaminants up the food chain to benthic-oriented piscivores that feed on round goby, although experimental results with various contaminants vary (Hogan et al. 2007, Morrison et al. 2000, Ng et al. 2008).*

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1

Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6 √
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U

- *The State of Ohio has shut down the smallmouth bass (*Micropterus dolomieu*) fishery in Lake Erie during the months of May and June because high predation rates by round goby on nests are affecting smallmouth bass recruitment. May and June normally account for 50 percent of the total smallmouth catch in Lake Erie (NISC 2004).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6 √
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U

- *Walleye anglers (*Sander vitreus*) in Detroit report that at times, all they can catch are gobies, which eagerly attack bait (Marsden and Jude 1995).*
- *It was noted in a survey-based study that round goby catches led to a perception of poor fishing quality and frustration among anglers (Dunning et al. 2006).*

Socio-Economic Impact Total	**13**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1 √
Not significantly	0
Unknown	U

- *Round goby consume zebra mussels; a significant gap in the food web is thus lessened (Johnson et al. 2005, Vanderploeg 2002), although predation only affected ~1% of dreissenid populations in Lake Erie*
- *Round goby appeared to make up approximately 75% of burbot (*Lota lota*) and smallmouth bass diet in*

Lake Erie and 36% of lake trout diet in Lake Ontario, indicating that a new energy source may be travelling up the food chain (Dietrich et al. 2006, Johnson et al. 2005).

- *Round goby also supplements the diet of yellow perch (Weber et al. 2011).*

Beneficial Effect Total	**1**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Notropis buchanani*

Common Name: Ghost shiner

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

Comments:
Information is available regarding morphology, distribution, and other life characteristics, but no evidence or descriptions of impact (or lack thereof) could be found in the literature.

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual	1

level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**5**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**

Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0
Unknown	U √

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1

Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Noturus insignis*

Common Name: Margined madtom

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0

Unknown	U

- *Hybrids between* Noturus insignis *and stonecat (*N. flavus*) were discovered in Monongahela River drainage in West Virginia.* Noturus flavus *is native to both the river drainage studied and the Great Lakes, while* N. insignis *is non-native to both regions (Welsh and Cincotta 2004). Two one-day population surveys were completed in this West Virginia drainage, the results of which, though limited, indicated that* N. insignis *appeared more abundant than the native* N. flavus*, and hybrid abundance appeared to match or exceed populations of* N. flavus *(Welsh and Cincotta 2004).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**1**
Total Unknowns (U)	**4**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus,

bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0
Unknown	U √

- Noturus insignis *is a popular bait fish in parts of the U.S. where it is more abundant (Mills et al. 1993, Phelps and Francis 2002). Its significance is unknown in the American Great Lakes (species distribution is limited), and it is unimportant in Canada, where the species makes no significant economic contribution (Phelps and Francis 2002).*

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1

Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Oncorhynchus gorbuscha*

Common Name: Pink salmon

Environmental: Unknown
Socio-Economic: Low
Beneficial: Moderate

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

- *Pink salmon may displace native chubs by way of food competition and may also compete with native cisco (*Coregonus artedi*) (Becker 1983).*
- *Pink salmon has also been identified as utilizing spawning habitats similar to those used by brook trout (*Salvelinus fontinalis*), potentially providing another mechanism of competition (Kocik and Jones 1999).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual	1

level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**1**
Total Unknowns (U)	**3**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

- *Genetic analysis of populations in the St. Marys River, MI indicates that pink salmon is capable of hybridizing with recreationally important Chinook salmon (*Oncorhynchus tshawytscha*) (Kirkpatrick et al. 2007). Hybridization has the potential to create further competition for the parental species, especially since the hybrid appears to have growth rates that exceed those of pink and Chinook salmon.*
- *Individuals over one year old feed heavily on rainbow smelt (*Osmerus mordax*) and alewife (*Alosa pseudoharengus*), which are important components of the diets of other Great Lakes salmonids (Diana 1990, Kocik and Taylor 1987, Kocik et al. 1991).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the	6

natural or cultural character of the area, or significantly reduced the area's value for future generations	
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**1**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

<u>BENEFICIAL EFFECT</u>

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1 √
Not significantly	0
Unknown	U

- *Although pink salmon is not stocked in the Great Lakes like most introduced salmonids, it has spread to all of the Great Lakes; individuals over one year old feed heavily on introduced rainbow smelt and alewife (Diana 1990, Kocik and Taylor 1987, Kocik et al. 1991).*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1 √
Not significantly	0
Unknown	U

- *Although pink salmon is not stocked in the Great Lakes like most introduced salmonids, it has spread to all of the Great Lakes, and plays a part in the lakes' recreational fisheries (Kocik and Taylor 1987). However, it has reportedly been caught more frequently by anglers in spawning streams (MIDNR 2003).*

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

Beneficial Effect Total	**2**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**<u>Moderate</u>**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Oncorhynchus kisutch*

Common Name: Coho salmon

Environmental: Moderate
Socio-Economic: Low
Beneficial: High

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- *The introduction of Pacific salmonines is deemed responsible for the introduction of* Renibacterium salmoninarum*, which has caused breakouts of bacterial kidney disease in lake trout (*Salvelinus namaycush*) and has also infected brook trout (*S. fontinalis*), lake whitefish (*Coregonus clupeaformis*), and bloater (*C. hoyi*). However, the specific role of coho salmon in this introduction is unknown (Crawford 2001, see GLANSIS fact sheet for* R. salmoninarum*).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

- *Fausch and White (1986) suggested that juvenile coho salmon has the ability to outcompete both native brook trout (*Salvelinus fontinalis*) and non-native brown trout (*Salmo trutta*) for food and space in Great Lake tributaries based on laboratory stream experiments involving competition for profitable stream positions. The authors also observed that coho salmon emerges earlier in tributaries, which may give it a competitive advantage in size over brook and brown trout (Fausch and White 1986).*
- *Coho salmon competes with native lake trout (*Salvelinus namaycush*) (Page and Laird 1993).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0

Unknown	U √

- *Although coho salmon is thought to be less voracious than Chinook (*Oncorhynchus tshawytscha*), controversy has existed in the Great Lakes regarding the effects Pacific salmonines have had on the forage fish base, on which other recreational/commercial species depend (Brown et al. 1999).*
- *The diet of coho salmon is diverse, including invasive species such as alewife (*Alosa pseudoharengus*) and rainbow smelt (*Osmerus mordax*), and native species such as yellow perch (*Perca flavescens*), emerald shiner (*Notropis atherinoides*), ninespine stickleback (*Pungitius pungitius*), cisco (*Coregonus artedii*), and many aquatic invertebrates (see Crawford 2001).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *Rand et al. (1992) found that phosphorus released from salmon carcasses was responsible for >50% of the total phosphorus discharged in some Lake Ontario streams during parts of the spring.*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *Hildebrand (1971) found that spawning significantly reduced the number and weight of invertebrates·ft^{-2} over the short term due to disturbance of bottom material. Total abundance and weight were reduced by 66% and 78%, respectively, relative to controls in the December following the autumn 1967 spawning (Hildebrand 1971).*

Environmental Impact Total	**3**

Total Unknowns (U)	2

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

<u>BENEFICIAL EFFECT</u>

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6 √
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0
Unknown	U

- *Coho salmon was stocked in all of the Great Lakes by 1968 as a control of alewife populations and as a sport fish (Eddy and Underhill 1974).*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6 √
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0
Unknown	U

- *They contributed substantially to the recreational fishery, although currently, they are only stocked in Lake Michigan and in small numbers in Lake Ontario (FWS/GLFC 2010, Kocik and Jones 1999, NYDEC 2011).*
- *According to the 2005 Survey of Recreational Fishing in Canada, coho salmon is still harvested by anglers in much of the Great Lakes system, but is less prominent than Chinook salmon and many native recreational species (Fisheries and Oceans Canada 2008).*

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**12**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	<u>**High**</u>
2-5	Any	Moderate
0	0-1	Low
1	0	

0	≥2	Unknown
1	≥1	

Scientific Name: *Oncorhynchus mykiss*

Common Name: Rainbow trout

Environmental: High
Socio-Economic: Low
Beneficial: High

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *Stocking of hatchery rainbow trout in rivers has led to the introduction of whirling disease into open waters of approximately 20 states including, most recently, the Madison River and its tributaries in Montana (B. Nehring and R. White, pers. comm.). Both non-native and native salmonids are susceptible to the disease (Yoder 1972). In the Madison River, the disease has reduced the rainbow trout population by 90% (White, pers. comm.).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6 √
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U

- *Clark and Rose (1997), Fausch (1988), and numerous papers cited in both discussed several factors affecting competitive interactions between rainbow and brook trout (*Salvelinus fontinalis*), although the overall impact of this competition on brook trout is not well known (Crawford 2001). Reportedly, rainbow trout also drive nongame fishes such as suckers and northern pikeminnow (*Ptychocheilus oregonensis*) from feeding territories (Li, pers. comm. to P. Moyle in Moyle 1976).*
- *Rainbow trout and brown trout (*Salmo trutta*) were deemed at least partially responsible for the extirpation of Arctic grayling (*Thymallus arcticus*) in Michigan, its only known location in the Great Lakes basin (Crawford 2001).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have	1 √

not been widespread or severe	
Not significantly	0
Unknown	U

- *Feltmate and Williams (1989) found that the introduction of rainbow trout to an enclosure within a Great Lakes tributary in Ontario cause a 35% decline in stonefly abundance relative to areas without rainbow trout. Stonefly populations were adversely affected by both predation and disturbance, which led to emigration (Feltmate and Williams 1989).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *Rainbow trout hybridizes with other rarer trout species, thereby affecting their genetic integrity (Page and Burr 1991, Rinne and Minckley 1985).*
- *Abundant examples exist of hybridization with native trout outside the Great Lakes leading to detrimental effects (e.g., Lahontan cutthroat trout (*O. clarki henshawi*), golden trout (*O. aguabonita*), and redband trout (*O. mykiss *subsp.)) (Behnke 1992, McAffee 1966a, Moyle 1976).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- *Crawford et al. (2001) pointed out that salmonids have the potential to alter the energy and nutrient cycles of the Great Lakes system through increased energy transfer between open water and streams/tributaries. This energy transfer includes the addition of nitrogen and phosphorous to tributaries through decaying salmonine carcasses, as well as the addition of salmon eggs and dead fish as a food source in streams (Ivan et al. 2011, Parmenter and Lamarra 1991, Rand et al. 1992). The presence of live salmonids may have an even greater effect on nutrients in streams through the excretion of ammonium and soluble reactive phosphorus and their mechanical disturbance of the stream bottom (Ivan et al. 2011, Tiegs et al. 2009).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR	1

It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U √

Environmental Impact Total	**9**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	**<u>High</u>**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

<u>SOCIO-ECONOMIC IMPACT</u>

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6 √
Yes, but its economic contribution is small	1

Not significantly	0
Unknown	U

- *The global production of aquacultured rainbow trout has grown continuously, annually producing over 700,000 tons as of 2010 (FAO 2005b).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6 √
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0
Unknown	U

- *Rainbow trout has been stocked as a recreational species in the Great Lakes since the 1800s and are currently stocked in all five lakes and Lake St. Clair (FWS/GLFC 2010, NYDEC 2011).*
- *The U.S. Fish and Wildlife Service (2006) estimated that nationally, every dollar spent on hatchery programs for rainbow trout returns over $36 of net economic value. One survey estimated the rainbow trout recreational fishery to be worth up to $12-14 million annually in Lake Erie, compared to a stocking cost of $600,000 (Kelch et al. 2006).*

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0
Unknown	U √

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

- *Eggs spawned by steelhead have been found to comprise an important part of the native brown trout diet in Great Lakes tributaries, but the effects of this consumption have yet to be understood (Ivan et al. 2011).*

Beneficial Effect Total	**12**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	**<u>High</u>**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Oncorhynchus nerka*

Common Name: Kokanee salmon

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √

Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Environmental Impact Total	**0**
Total Unknowns (U)	**4**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6

Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1 √
Not significantly	0
Unknown	U

- *In the Great Lakes, it was originally stocked in Lakes Ontario and Huron in order to support recreational and potentially commercial fisheries. However, stocking in both lakes ceased by the early 1970s (Crawford 2001, Kocik and Jones 1999).*

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**1**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Oncorhynchus tshawytscha*

Common Name: Chinook salmon

Environmental: Moderate
Socio-Economic: Low
Beneficial: High

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

- *The introduction of Pacific salmonines is deemed responsible for the introduction of* Renibacterium salmoninarum*, which has caused breakouts of bacterial kidney disease in lake trout (*Salvelinus namaycush*) and has also infected brook trout (*S. fontinalis*), lake whitefish (*Coregonus clupeaformis*), and bloater (*C. hoyi*). However, the specific role of coho salmon in this introduction is unknown (Crawford 2001, see GLANSIS fact sheet for* R. salmoninarum*).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

- *In the Great Lakes, Chinook salmon competes with native lake trout (*Salvelinus namaycush*) (Page and Laird 1993).*
- *Scott et al. (2003) found that the presence of Chinook salmon causes delayed nesting and reduced survival of Atlantic salmon (*Salmo salar*) during spawning in Lake Ontario.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1 √
Not significantly	0
Unknown	U

- *Chinook salmon is a predatory fish and may impact populations of smaller fish. Jones et al. (1993)*

predicted that maintaining high levels of predator demand by stocking Chinook and other top predators at the current rate would eventually lead to an alewife collapse, possibly followed by the further collapse of other small forage fish populations.

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- *Crawford et al. (2001) pointed out that salmonids have the potential to alter the energy and nutrient cycles of the Great Lakes system through increased energy transfer between open water and streams/tributaries. This energy transfer includes the addition of nitrogen and phosphorous to tributaries through decaying salmonine carcasses, as well as the addition of salmon eggs and dead fish as a food source in streams (Ivan et al. 2011, Parmenter and Lamarra 1991, Rand et al. 1992). The presence of live salmonids may have an even greater effect on nutrients in streams through the excretion of ammonium and soluble reactive phosphorus and their mechanical disturbance of the stream bottom (Ivan et al. 2011, Tiegs et al. 2009).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**2**
Total Unknowns (U)	**3**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6 √
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0
Unknown	U

- *Chinook salmon was introduced to control alewife populations in the 1960s; since then, some agencies in Lakes Michigan and Ontario have drastically reduced their stocking quotas for Chinook salmon and are now concerned about their impact on declining populations of alewife (Schreiner 1995).*
- *Chinook had totally eliminated rainbow smelt* Osmerus mordax *in two small New Hampshire lakes where the salmon was stocked to control the smelt (McAffee 1966b).*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1√
Not significantly	0
Unknown	U

- *Chinook salmon is a significant catch of the Native American commercial harvest, especially in Lake Huron (Bence and Smith 1999).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6 √
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0
Unknown	U

- *Chinook salmon has remained an important component of the Great Lakes fisheries, and is recreationally and economically valuable: from 1967 to 1993, over 259 million Chinook salmon were stocked in the Great Lakes (Kocik and Jones 1999); in 2005, nearly 9.5 million Chinook salmon were stocked in the Great Lakes system (not including Lake Erie) as reported by various agencies (FWS/GLFC 2010).*
- *A 2005 survey of anglers fishing in Canada reported an annual recreational harvest of 426,890 Chinook salmon in the Great Lakes system (Fisheries and Oceans Canada 2008).*

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

- *Eggs spawned by Chinook salmon have been found to comprise an important part of the native brown trout diet in Great Lakes tributaries, but the effects of this consumption have yet to be understood (Ivan et al. 2011).*

Beneficial Effect Total	**13**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact

>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Osmerus mordax*

Common Name: Rainbow smelt

Environmental: High
Socio-Economic: Unknown
Beneficial: High

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6 √
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U

- *In the Great Lakes, rainbow smelt may compete with cisco (*Coregonus artedi*) for food (Becker 1983). Christie (1974) supplied some evidence to support this, correlating cisco decline with smelt increases in most of the lake.*
- *Both predation by and competition with rainbow smelt have been implicated in the declines of several endangered or special concern species in Canada, including blackfin cisco (*Coregonus reighardi*) and shortnose cisco (*Coregonus reighardi*), as well as deepwater sculpin (*Myoxocephalus thompsonii*) (COSEWIC 2005, 2006, 2007). Todd (1986) also reported that smelt may be partially responsible for the decline of whitefishes (*Coregonus *spp.) in the Great Lakes.*
- *Hrabik et al. (1998) found evidence of competition for food between introduced rainbow smelt and native yellow perch (*Perca flavescens*) in Wisconsin lake habitats.*
- *In a review of rainbow smelt introductions in inland Ontario lakes, Evans and Loftus (1987) found that 13 of 24 lakes with introduced rainbow smelt experienced a decline in lake whitefish (*Coregonus clupeaformis*) recruitment while 5 of 19 reported declines in cisco.*
- *A study of Wisconsin inland lakes with and without introduced rainbow smelt from 1985-2004 found that young-of-the-year walleye (*Sander vitreus*) density was significantly lower in invaded lakes (Mercado-Silva et al. 2007).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6 √
Yes, and it has resulted in some noticeable stress to or decline of at least one native species	1

population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	
Not significantly	0
Unknown	U

- *In different ecosystems, rainbow smelt may be an important a prey item, predator, or competitor (Evans and Loftus 1987); in many cases, it may participate in multiple roles relative to a native species.*
- *Declines, local extirpations, and limitations to recovery of cisco populations have also been attributed to rainbow smelt predation on larval fish rather than competition (Hrabick et al. 1998, Stockwell et al. 2009).*
- *In a review of rainbow smelt introductions in inland Ontario lakes, Evans and Loftus (1987) found that 13 of 24 lakes with introduced rainbow smelt experienced a decline in lake whitefish (*Coregonus clupeaformis*) recruitment; rainbow smelt are known to feed on the young of lake whitefish.*
- *A study of Wisconsin inland lakes with and without introduced rainbow smelt from 1985-2004 found that young-of-the-year walleye (*Sander vitreus*) density was significantly lower in invaded lakes (Mercado-Silva et al. 2007).*
- *Both predation by and competition with rainbow smelt have been implicated in the declines of several endangered or special concern species in Canada, including blackfin cisco (*Coregonus reighardi*) and shortnose cisco (*Coregonus reighardi*), as well as deepwater sculpin (*Myoxocephalus thompsonii*) (COSEWIC 2005, 2006, 2007). Todd (1986) also reported that smelt may be partially responsible for the decline of whitefishes (*Coregonus *spp.) in the Great Lakes.*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild	1

AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U √

Environmental Impact Total	**12**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	**<u>High</u>**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

<u>SOCIO-ECONOMIC IMPACT</u>

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

- *Important recreational species such as walleye and lake trout may both benefit and suffer from introductions of rainbow smelt depending on the extent to which rainbow smelt acts as a prey item, predator, or competitor (Evans and Loftus 1987).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**3**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6 √
Yes, but its economic contribution is small	1
Not significantly	0
Unknown	U

- *It was estimated in 2003 that the commercial smelt harvest in the U.S. Great Lakes alone was worth over \$750,000 yr^{-1}—more than lake trout, cisco, or Pacific salmons (Dann and Schroeder 2003).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1 √
Not significantly	0
Unknown	U

- *Rainbow smelt provides a food source to many recreationally important piscivores in the Great Lakes, including native burbot (*Lota lota*), yellow perch, and introduced salmonids. Species such as walleye and lake trout may both benefit and suffer from introductions of rainbow smelt depending on the extent to which rainbow smelt acts as a prey item, predator, or competitor (Evans and Loftus 1987).*
- *Historically, recreational harvest of rainbow smelt has also been popular (Scott and Crossman 1998); an annual harvest of over 150,000 rainbow smelt in the Great Lakes system was recently reported in a 2005 survey of anglers in Canada (Fisheries and Oceans Canada 2008).*

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

- *Rainbow smelt have been used by USGS to monitor contaminant levels in the Great Lakes (Chernyak et al. 2005).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6 √
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U

- *Because so many species—including recreational and commercial species—depend on rainbow smelt as a food source, rainbow smelt is a vital member of the current food web and are considered by some to be an important species to manage and conserve (Schmidt et al. 2009).*

Beneficial Effect Total	**14**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Petromyzon marinus*

Common Name: Sea lamprey

Environmental: High
Socio-Economic: High
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6 √
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

- *Attack and parasitic feeding on other fishes by adult sea lamprey often result in death of the prey, either directly from the loss of fluids and tissues or indirectly from secondary infection of the wound (Phillips et al. 1982). Of the fish that survived attacks by sea lamprey, 85% of various species had been attacked up to five times (Scott and Crossman 1973).*
- *Although the number of sea lamprey in the Great Lakes has been reduced, this species still wounds or kills substantial numbers of lake trout in some areas and, thus, is impeding the rebuilding of established populations (Adair and Young 2007, Madenjian et al. 2008b, Schneider et al. 1996 and references therein).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6 √
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U

- *Because the sea lamprey had greatly reduced the population of large predators, alewife populations exploded and were followed by tremendous die-offs, resulting in additional changes to fish species composition in the lakes (Smith and Tibbles 1980).*

- *The species' introduction to the Great Lakes and its later abundance, combined with water pollution and overfishing, resulted in the decline of several large native species, including several ciscoes (*Coregonus *spp.), lake trout (*Salvelinus namaycush*), and walleye (*Sander vitreus*), among others.*
- *A recent study in northern Lake Michigan found that sea lamprey wounding rates in this region have increased from 1990-1999 to 2000-2008, despite continued management of sea lamprey populations (Madenjian and Desorcie 2010).*
- *In combination with other factors (e.g., overfishing and hybridization with more common cisco species), sea lamprey predation led to the extinction of the deepwater cisco (*Coregonus johannae*) and shortnose cisco (*C. reighardi*), and the dramatic decline of the blackfin cisco (*C. nigripinnis*), all endemic to the Great Lakes (Jelks et al. 2008, World Conservation Monitoring Centre 1996).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

- *Although indirect impacts may be more difficult to attribute to sea lamprey, changes in fish species composition spurred by sea lamprey introduction (especially the proliferation of alewife) have likely had far-reaching indirect effects on other biotic and abiotic components of the Great Lakes ecosystems, including plankton communities (J. Gunderson, MN Sea Grant, pers. comm. 2010).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

- *Although indirect impacts may be more difficult to attribute to sea lamprey, changes in fish species composition spurred by sea lamprey introduction (especially the proliferation of alewife) have likely had* *far-reaching indirect effects on other biotic and abiotic components of the Great Lakes ecosystems, including plankton communities (J. Gunderson, MN Sea Grant, pers. comm. 2010).*

Environmental Impact Total	**12**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	**<u>High</u>**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

<u>SOCIO-ECONOMIC IMPACT</u>

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6 √
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

- *The introduction of sea lamprey caused a collapse in the commercial fisheries during the 1940s and 1950s in many parts of the Great Lakes, particularly in lakes Huron and Michigan, and in eastern Lake Superior (e.g., Becker 1983, Christie 1974, Courtenay 1993, Emery 1985, Lawrie 1970, Scott and Crossman 1973, Smith and Tibbles 1980).*
- *Furthermore, the cascading impact of sea lamprey introduction, beginning with the decline of native commercially fished species and resulting in the explosion of introduced forage fishes and Pacific salmonid stocking, was the major force resulting in the transition of the Great Lakes fisheries from being primarily commercial-based to primarily recreation-based (J. Gunderson, MN Sea Grant, pers. comm. 2010).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6 √
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U

- *Besides causing declines of native lake trout (*Salvelinus namaycush*), and walleye (*Sander vitreus*), sea lamprey also took a toll on the introduced salmon in the Great Lakes, much to the dismay of anglers and state fish agencies (Scott and Crossman 1973).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6 √
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U

- *Following the collapse of fish stocks in the mid 20th century, sea lamprey was reportedly the best-publicized cause of the problem (Francis et al. 1979).*

Socio-Economic Impact Total	**18**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	**<u>High</u>**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Phenacobius mirabilis*

Common Name: Suckermouth minnow

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √

Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1

Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0
Unknown	U √

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

<table>
<tr><th colspan="3">Scoring</th></tr>
<tr><td>Score</td><td># U</td><td>Impact</td></tr>
<tr><td>>5</td><td>Any</td><td>High</td></tr>
<tr><td>2-5</td><td>Any</td><td>Moderate</td></tr>
<tr><td>0</td><td>0-1</td><td rowspan="2"><u>Low</u></td></tr>
<tr><td>1</td><td>0</td></tr>
<tr><td>0</td><td>≥2</td><td rowspan="2">Unknown</td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

Scientific Name: *Proterorhinus semilunaris*

Common Name: Tubenose goby

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

- *Tubenose goby has been shown to have a significant overlap in diet preference with rainbow darter (*Etheostoma caeruleum*) and may compete with this native fish for food (French and Jude 2001).*
- *It shares a preference for rocky spawning sites with johnny darter (*E. nigrum*), but the results of this potential competition remain to be seen (Kocovsky et al. 2011).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual	1

level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**3**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

<u>BENEFICIAL EFFECT</u>

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Salmo trutta*

Common Name: Brown trout

Environmental: High
Socio-Economic: Low
Beneficial: High

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *Introduction of the bacteria* Aeromanas salmonicida *was likely a result of brown trout stocking and has led to cases of furunculosis in both native and non-native salmonids, including brook trout (*Salvelinus fontinalis*), Arctic grayling (*Thymallus arcticus*), and lake whitefish (*Coregonus clupeaformis*) (Crawford et al. 2001, see GLANSIS fact sheet on* A. salmonicida*.)*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6 √
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U

- *Fausch and White (1981) found that adult brown trout displaced adult native brook trout (*Salvelinus fontinalis*) from the best habitats in a Michigan stream and from the northeast in general.*
- *Waters (1999) observed a large-scale replacement of brook trout by brown trout following the introduction of brown trout in Valley Creek, MN. Brown trout production increased to 95% of trout biomass in the stream by the end of the 15-year study (Waters 1999).*
- *Brown trout and rainbow trout (*Oncorhynchus mykiss*) were deemed at least partially responsible for the extirpation of Arctic grayling (*Thymallus arcticus*) half a century ago in Michigan, its only known location in the Great Lakes basin (Crawford 2001, p. 143).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1 √

Not significantly	0
Unknown	U

- *Brown trout has been implicated in reducing native fish populations (especially other salmonids) through predation, displacement, and food competition (Taylor et al. 1984).*
- *A review by Townsend (1996) documented many impacts of brown trout introductions that have been studied in New Zealand, including predation of native galaxiids and their exclusion from stream habitat, potential reduction in insect and other invertebrate populations that may lead to reduced grazing, increased algal biomass and other trophic effects, and facilitation of the evolution of anti-predator behavior of some invertebrates.*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *A study by Grant (2002) in Valley Creek, MN, confirmed that hybridization between male brown trout and female brook trout occurs in the wild, resulting in a hybrid fish known as tiger trout. It also indicated that the interference of brown trout in conspecific brook trout reproduction could contribute to declines in brook trout populations (Grant 2002).*
- *Natural hybridization between brown trout and Atlantic salmon (*Salmo salar*), a Lake Ontario native, has been frequently documented in Europe (Álvarez and Garcia-Vasquez 2011, Hartley 1996, Matthews et al. 2000). Survival is reportedly highest among male trout x female salmon hybrids, which may have similar levels of survival to pure salmon while emerging earlier as fry (Álvarez and Garcia-Vasquez 2011).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**9**
Total Unknowns (U)	**2**

Scoring		
Score	# U	**Impact**
>5	Any	**<u>High</u>**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

<u>SOCIO-ECONOMIC IMPACT</u>

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small	1

AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

- *Brown trout were reportedly less popular as a sportfish than brook trout upon their stocking in the Great Lakes (Bence and Smith 1999)*

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1

Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6 √
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0
Unknown	U

- *As of 2009, brown trout continues to be stocked as a sport fish to bolster recreational fisheries in all five Great Lakes and Lake St. Clair (FWS/GLFC 2010, NYDEC 2011). This species has grown in popularity and contributed substantially to the recreational harvest in most of the Lakes (Bence and Smith 1999, Fisheries and Oceans Canada 2008).*

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**6**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	<u>**High**</u>
2-5	Any	Moderate
0	0-1	Low
1	0	

0	≥2	Unknown
1	≥1	

Scientific Name: *Scardinius erythrophthalmus*

Common Name: Rudd

Environmental: Moderate
Socio-Economic: Unknown
Beneficial: Unknown

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0

Unknown	U

- *In a laboratory setting, Burkhead and Williams (1991) demonstrated that rudd readily hybridizes with native golden shiner (*Notemigonus crysoleucas*), a primary forage species of many native game fishes. First generation hybrids offspring should show heterosis (or hybrid vigor), but the "genetic pollution" in subsequent generations could prove detrimental due to a variety of factors (e.g., spawning behavior, recruitment success, and general loss of fitness) (Burkhead and Williams 1991, Courtenay and Williams 1992).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *Rudd can contribute to ecosystem modification due to their inefficiency of nutrient assimilation, which causes much of the nutrients they obtain from macrophytes to be returned to the water column through feces deposition (Lake et al. 2002).*
- *In New Zealand, its main source of food, the macrophyte* Egeria*, collapsed over time as secchi depth decreased. Rudd persisted even after the decline of* Egeria*, shifting its diet to other plants (Hicks 2003).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *Rudd likely contributed to the shift in Hamilton Lake, New Zealand from a macrophyte to phytoplankton community; its main source of food, the macrophyte* Egeria*, collapsed over time as secchi depth decreased (Hicks 2003).*

Environmental Impact Total	**3**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low

1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0
Unknown	U √

- *The interest in bait culture of rudd dramatically intensified in the early 1980s. The central Arkansas region of Lonoke and Prairie counties, an area known for its active fish farming industry, apparently became the largest producer of rudd in the United States. Rudd has been widely introduced through a combination of bait bucket releases, escapes from aquaculture facilities and farm ponds, and, presumably, by dispersal from various points of introduction (e.g., Burkhead and Williams 1991).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1 √
Not significantly	0
Unknown	U

- *Rudd has become a popular sportfish in New Zealand (Hicks 2003) and is a popular baitfish in general (Litvak and Mandrak 1993, Marsden and Hauser 2009, see GLANSIS fact sheet). Bait bucket release seems to be the primary mechanism by which rudd has gained access into open waters. It appears that the greatest dispersal of rudd has been through interstate traffic rather than direct European import. In fact, much of its recent culture and spread can be attributed to its popularity as bait among striped bass (*Morone saxatilis*) anglers.*

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered species, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

Beneficial Effect Total	**1**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

A.2 Annelids

Scientific Name: *Branchiura sowerbyi*

Common Name: Tubificid worm

Environmental: Unknown
Socio-Economic: Low
Beneficial: Unknown

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- Branchiura sowerbyi*, with other oligochaetes, has been documented as a host of myxosporean parasites including such fish pathogens as cause swim-bladder disease and haemorrhagic thelohanellosis in Asia and Europe; its presence has been correlated to high levels of infection in fish (Liyanage et al. 2003).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U√

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline	6

or extinction of one or more native species	
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- *Due to its larger size,* B. sowerbyi *can homogenize layers to a greater depth than some other oligochaetes that are abundant in parts of the Great Lakes, including* Limnodrilus hoffmeisteri *and* Tubifex tubifex *(Matisoff et al. 1999).*

Environmental Impact Total	**1**
Total Unknowns (U)	**5**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6

Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0
Unknown	U √

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

- Branchiura sowerbyi *has been used in the past as a research organism to determine toxic levels of various chemicals (e.g., Das and Das 2005, Ghosh and Konar 1983, Saha et al. 2006).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**1**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**<u>Unknown</u>**
1	≥1	

Scientific Name: *Gianius aquaedulcis*

Common Name: Tubificid worm

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0

Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**6**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1

Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**1**

Scoring

Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Potamothrix bedoti*

Common Name: Tubificid worm

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0

Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**6**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1

Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**1**

Scoring

Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

- *Some studies suggest that* Potamothrix *spp. may have a positive impact on native oligochaetes in Europe. The benefit could result from the numerous bacteria found in* Potamothrix *spp. faeces, which could allow for improved feeding by natives (Milbrink and Timm 2001).*

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Potamothrix moldaviensis*

Common Name: Tubificid worm

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0

Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Environmental Impact Total	**0**
Total Unknowns (U)	**6**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1

Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**1**

Scoring

Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

- *Some studies suggest that* Potamothrix spp. *may have a positive impact on native oligochaetes in Europe. The benefit could result from the numerous bacteria found in* Potamothrix *spp. faeces, which could allow for improved feeding by natives (Milbrink and Timm 2001).*

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Potamothrix vejdovskyi*

Common Name: Tubificid worm

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

- *It is possible, but not confirmed, that* P. vejdovskyi *competes with* Tubifex tubifex *(Lang and Lang-Dobler 1979).*
- *In a review of the potential invaders of Finnish lakes, Pienimäki and Leppäkoski (2004) listed competition with native species and habitat alteration as potential impacts of* P. vejdovskyi *introduction.*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual	1

level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Environmental Impacts Total	**0**
Total Unknowns (U)	**6**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**

Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1

Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

- *Some studies suggest that* Potamothrix spp. *may have a positive impact on native oligochaetes in Europe. The benefit could result from the numerous bacteria found in* Potamothrix *spp. faeces, which could allow for improved feeding by natives (Milbrink and Timm 2001).*

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Ripistes parasita*

Common Name: Oligochaete worm

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0

Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**6**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1

Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

- Ripistes parasita *does not burrow into soft substrate or sediment like some annelids; rather, it attaches to hard surfaces, including macrophytes or rocks (Smith and Abele 1984). This may have implications for man-made infrastructure; however, the potential to attach to and affect infrastructure is unstudied and lacks any mention in the literature thus far.*

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**

Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1

Not significantly	0
Unknown	U √

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered species, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

A.3 Arthropods (Non-crustacean)

Scientific Name: *Acentria ephemerella*

Common Name: Water moth

Environmental: Unknown
Socio-Economic: Low
Beneficial: Moderate

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR	1

It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *A study done at Lake Constance in Europe found* A. ephemerella *to be an ecosystem engineer through its control of macrophyte communities (largely of* P. perfoliatus*) that many other species, including young-of-the-year (YOY) and adult fish such as perch, sticklebacks, and pike, used as habitat (Miler 2008).*

Environmental Impact Total	**1**
Total Unknowns (U)	**3**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**

Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1 √
Not significantly	0
Unknown	U

- Acentria ephemerella *has had some success as a biological control agent of Eurasian watermilfoil (*Myriophyllum spicatum*) in the Great Lakes region.*
- *In Lakes Buckhorn and Scugog, part of the Trent Canal system flowing into Lake Ontario, populations of introduced Eurasian watermilfoil were decimated in the 1980s, likely due to grazing by* A. ephemerella *(Painter and McCabe 1988).*
- *In Cayuga Lake, the introduction of* A. ephemerella *was associated with a decline in* M. spicatum *populations and the recovery of native macrophytes (particularly* Elodea canadensis*) during the 1990s (Gross et al. 2001, Johnson et al. 1998, Johnson et al. 2000).*
- *A review on the biocontrol of Eurasian watermilfoil in North America agrees that* A. ephemerella*, along with* E. lecontei *and* Cricotopus myriophylli, *has the potential to be an effective control agent; however, populations in many study sites were lacking the densities of* A. ephemerella *needed to be fully effective (Newman 2004).*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0
Unknown	U √

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1√
Not significantly	0
Unknown	U

- *A review on biocontrol of Eurasian watermilfoil in North America agrees that* A. ephemerella *has the potential to be an effective control agent (Newman 2004), and has led to declines in this aquatic macrophyte in Cayuga Lake and the Kawartha Lakes area (Johnson et al. 1998, Johnson et al. 2000, Painter and McCabe 1988).*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

Beneficial Effect Total	**2**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**<u>Moderate</u>**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Tanysphyrus lemnae*

Common Name: Duckweed weevil

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √

Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**4**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1

Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring

Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0
Unknown	U √

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

A.4 Bryozoans

Scientific Name: *Lophopodella carteri*

Common Name: Freshwater bryozoan

Environmental: Unknown
Socio-Economic: Unknown
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

- *The coelomic fluid of* L. carteri *is known to kill fish and salamanders by damaging gill tissue; however* L. carteri *has been documented in the stomach of at least one live fish in the Great Lakes, yellow perch (*Perca flavescens*) (Ricciardi and Reiswig 1994).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6

Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Environmental Impact Total	**0**
Total Unknowns (U)	**4**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- *Encrusting bryozoans, in general, can easily become an economic nuisance by fouling boating and recreational equipment, aquaculture infrastructure, and water intake systems (Ricciardi and Reiswig 1994).*

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √

Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**4**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0
Unknown	U √

- *Lauer et al. (1999) suggested three ways in which* L. carteri *could prevent recruitment of the zebra mussel* Dreissena polymorpha*: (1) the current produced by bryozoans' lophophore cilia (used for food selection, waste rejection) may physically prevent* D. polymorpha *larvae from settling; (2) the cover produced by* L. carteri *colonies may cause* D. polymorpha *larvae to seek alternate substrates; and (3) the coelomic fluid of* L. carteri *fluid may have a detrimental effect on* D. polymorpha *larvae.*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR	1

It is potentially important to medicine or research and is currently being or scheduled to be studied	
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered species, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

A.5 Coelenterates

Scientific Name: *Cordylophora caspia*

Common Name: Freshwater hydroid

IMPACT RESULTS

Environmental: Unknown
Socio-Economic: Unknown
Beneficial: Low

Comments:
Studies have suggested that *Cordylophora caspia* may contribute to the restructuring of benthic and pelagic freshwater communities (Folino 2000). For example, research found that as compared to uncolonized control substrates, the successful inoculation of a substrate with *C. caspia* resulted in a shift in relative abundance of other invertebrates (Ruiz et al. 1999). The specific mechanism is unknown.

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**4**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *There are economic costs associated with the biofouling caused by* Cordylophora caspia *(Folino 2000).* Cordylophora *has reportedly caused blockages of intake tunnels and filters and colonize docks, piers, and pilings near Chicago harbors of Lake Michigan.*
- Cordylophora *has had degrading effects on cement and mortar at Brazilian power plants (Berg and Folino-Rorem 2009, Folino 2000, Portella and Joukoski 2009).*

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

Socio-Economic Impact Total	**1**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Craspedacusta sowerbyi*

Common Name: Freshwater jellyfish

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √

Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**4**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1

Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**1**

Scoring

Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0
Unknown	U √

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

A.6 Crustaceans

Scientific Name: *Argulus japonicus*

Common Name: Parasitic oarsman

Environmental: Unknown
Socio-Economic: Unknown
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- Argulus japonicus *parasitizes introduced channel catfish (*Ictalurus punctatus*) in Tichigan Lake, which adjoins the Fox River in Wisconsin as part of the Lake Michigan drainage system. However, it is most typically found on* Carassius auratus *and* Cyprinus carpio *in drainages in the United States (Amin 1981).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline	6

or extinction of one or more native species	
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	**1**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus,

bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

- Argulus japonicus *parasitizes introduced channel catfish (*Ictalurus punctatus*). However, it is most typically found on* Carassius auratus *and* Cyprinus carpio *in drainages in the United States (Amin 1981).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U√

- Argulus japonicus *parasitizes introduced channel catfish (*Ictalurus punctatus*) in Tichigan Lake, which adjoins the Fox River in Wisconsin as part of the Lake Michigan drainage system (Amin 1981).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1

Not significantly	0
Unknown	U√

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**3**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Bythotrephes longimanus*

Common Name: Spiny waterflea

Environmental: High
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

- *Significant increases in the trophic position of zooplankton (reduced herbivorous cladoceran biomass and increased omnivorous/predatory copepod biomass) and planktivorous fish such as the lake herring (*Coregonus artedi*) with the introduction of* Bythotrephes *has the potential to lead to substantial contaminant biomagnification in consumers (Rennie et al. 2011). However, increased mercury concentrations in consumers has not be observe following invasion; this may be attributed to increased foraging and growth efficiencies of consumers or to changes in the feeding habits of omnivorous prey (Rennie et al. 2011).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

- Bythotrephes *consumes small zooplankton such as small cladocerans, copepods, and rotifers, potentially competing directly with planktivorous larval fish for food (Berg and Garton 1988, Evans 1988, Vanderploeg et al. 1993).*
- *Many studies have documented a negative correlation between abundances of* Bythotrephes *and* Leptodora *(a native waterflea), implying that competition and/or predation from* Bythotrephes *has played a significant role in observed declines of* Leptodora *(e.g., Branstrator 1995, Fernandez et al. 2009, Foster and Sprules 2009, Garton et al. 1990, Lehman and Cáceres 1993, Yan and Pawson 1997).*
- *Vertical migration has also been observed in* Daphnia *spp. and copepod (e.g.,* Diacyclops thomasi, Leptomdiaptomus ashlandi, L. minutus*) populations following* Bythotrephes *invasion, indicating that some species may alter their spatial distribution (migrate to deeper waters during the day) to avoid* Bythotrephes *predation or competition (Bourdeau et al. 2011, Jokela et al. 2011, Lehman and Cáceres 1993). Such migration can lead to an indirect negative effect on these native prey species, including reduced individual and population growth rates at lower temperatures (Pangle and Peacor 2006, Pangle et al. 2007).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6 √
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U

- *A decline in native cladocerans following the introduction of* Bythotrephes *has been observed in Lake Huron and Lake Michigan (Barbiero and Tuchman 2004). In Lake Erie, the detection of* Bythotrephes *in 1985 was also accompanied by a decline in multiple species of cladocerans (e.g.,* Eubosmina coregoni, Daphnia mendotae, D. retrocurva*), including an almost complete absence of* Diaphanosoma *spp. wherever* Bythotrephes *was present in 1986 (Barbiero and Rockwell 2008).*
- *In Lake Michigan, the decline of* D. retrocurva *and* D. pulicaria *populations in contrast to relatively stable populations of* D. mendotae *has been attributed to the latter's markedly faster escape responses (Pichlová-Ptáčníková and Vanderploeg 2011).*
- *In some cases,* Bythotrephes *has been associated with a shift in cladoceran communities towards larger taxa over small (likely due to* Bythotrephes *predation of smaller species) (Barbiero and Rockwell 2008, Hovius et al. 2007, Yan and Pawson 1997).*
- *Many studies have documented a negative correlation between abundances of* Bythotrephes *and* Leptodora *(a native waterflea), implying that competition and/or predation from* Bythotrephes *has played a significant role in observed declines of* Leptodora *(e.g., Branstrator 1995, Fernandez et al. 2009, Foster and Sprules 2009, Garton et al. 1990, Lehman and Cáceres 1993, Yan and Pawson 1997).*
- *Vertical migration has also been observed in* Daphnia *spp. and copepod (e.g., Di*acyclops thomasi, Leptomdiaptomus ashlandi, L. minutus*) populations following* Bythotrephes *invasion, indicating that some species may alter their spatial distribution (migrate to deeper waters during the day) to avoid* Bythotrephes *predation or competition (Bourdeau et al. 2011, Jokela et al. 2011, Lehman and Cáceres 1993). Such migration can lead to an indirect negative effect on these native prey species, including reduced individual and population growth rates at lower temperatures (Pangle and Peacor 2006, Pangle et al. 2007).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0

Unknown	U √

- *Some studies have documented an increase in chlorophyll a abundance with the invasion of* Bythotrephes, *potentially due to a release from grazing following increased predation pressure on zooplankton species (Barbiero and Rockwell 2008, Hovius et al. 2007). However, an increase in* Bythotrephes *abundance is not always correlated with an increase in chlorophyll* a *(Foster and Sprules 2009, Strecker and Arnott 2008).*
- *Notably, Strecker and Arnott (2008) demonstrated that invaded lakes experienced a significant reduction in secondary production, and hence a reduction in resources available, in the epilimnion.*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- *Some studies have documented an increase in chlorophyll a abundance with the invasion of* Bythotrephes, *potentially due to a release from grazing following increased predation pressure on zooplankton species (Barbiero and Rockwell 2008, Hovius et al. 2007). However, an increase in* Bythotrephes *abundance is not always correlated with an increase in chlorophyll* a *(Foster and Sprules 2009, Strecker and Arnott 2008).*

Environmental Impact Total	**7**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

- *The first noticeable impact of* Bythotrephes *was on fishermen. The tail spines of* Bythotrephes *hook on fishing lines, fouling fishing gear. This problem has largely been eliminated with a switch to line/gear types less susceptible to* Bythotrephes *fouling.*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Economic Impact Total	**1**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered species, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

- Bythotrephes *is a food source for fish including yellow perch, white perch, walleye, white bass, alewife, bloater chub, Chinook salmon, emerald shiner, spottail shiner, rainbow smelt, lake herring, lake whitefish, and deepwater sculpin (Branstrator and Lehman 1996, Bur et al. 1986, Makarewitz and Jones 1990). However due to its long tail spine, predation of* Bythotrephes *is mainly restricted to larger fish and non-gape limited species (Pothoven et al. 2007).*

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Cercopagis pengoi*

Common Name: Fishhook waterflea

Environmental: High
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

- *In Lake Ontario, it was also thought that the addition of a zooplanktivorous invertebrate could alter the food web and increase toxin biomagnification levels in top predators. Conversely, studies indicate that this is probably not the case, largely because alewife does not feed heavily on* C. pengoi *(Thompson et al. 2005).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

- Cercopagis pengoi*, a relatively small species, is a consumer of other small zooplankton nearly as large as itself, including small cladocerans (e.g.,* Bosmina longirostris*, early instars of* Daphnia *spp.), as well as nauplii and early copepodite stages of copepods (Pichlová-Ptáčniková and Vanderploeg 2009). As such, it competes with other planktivores of the Great Lakes, including alewife (*Alosa pseudoharengus*) and rainbow smelt (*Osmerus mordax*) (Bushnoe et al. 2003).*
- *Yearling alewife directly compete with* C. pengoi *because they are planktivorous but cannot consume* C. pengoi *due to its caudal appendage.*
- *The fishhook waterflea is likely to be a competitor of* L. kindtii *because of similar food preferences, similar life histories, and similar habitat preferences; both are found in the epilimnion. (Cavaletto et al. 2010, Pichlová and Vijverberg 2001, Pichlová-Ptáčniková and Vanderploeg 2009).*
- *Because of its large feeding appendages, it is possible that* C. pengoi *is a more effective predator of zooplankton of a broader range in size and escape abilities than is* L. kindtii *(Pichlová-Ptáčniková and Vanderploeg 2009).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6√

Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U

- *Unlike* B. longimanus*,* C. pengoi *is too small to impact populations of the native predatory cladoceran,* Leptodora kindtii*, via predation.*
- *Its long spine makes it less palatable to small planktivorous fish. For these reasons,* C. pengoi *could have a serious effect on the food supply of planktivores.*
- *The fishhook waterflea is known to make up a portion of the adult alewife diet in Lakes Ontario, Erie, and Michigan, but this contribution does not appear significant relative to* Bythotrephes longimanus*, another nonindigenous spined cladoceran, when these species co-occur (Pothoven et al. 2007, Stewart et al. 2009, Storch et al. 2007).*
- *The fishhook waterflea's establishment in Lake Ontario in 1998 corresponded with the lowest alewife populations in twenty years (Makarewicz et al. 2001). Surveys in the following year indicated that* C. pengoi *was found to account for as much as 73% of crustacean zooplanktonic biomass in the lake (Ojaveer et al. 2001).*
- *Many studies have been conducted on the food web effects of* C. pengoi *in Lake Ontario. A 2002 study showed that the depth at which* C. pengoi *exists is depleted of small organisms (<0.15 mg) in Lake Ontario (Benoit et al. 2002). It was unclear as to whether this is due to predator evasion or* C. pengoi *consumption, but in either case, the smaller organisms are forced into deeper, cooler strata, causing growth rate changes (Benoit et al. 2002).*
- *Further study in Lake Ontario indicated that in the years following* C. pengoi *invasion, the density of small zooplankton began to drop in the late summer and fall seasons (when* C. pengoi *is most abundant) (Warner et al. 2006). Importantly, Laxson et al. (2003) found that increasing* C. pengoi *abundance was correlated with declines in populations of native zooplankton* Daphnia retrocurva*,* Bosmina longirostris*, and* Diacyclops thomasi *in Lake Ontario between 1999 and 2001.* Daphnia retrocurva *and* B. longirostris *are important prey items of* C. pengoi*, and appeared to be limited by predation rather than food availability or any decrease in fecundity (Laxson et al. 2003). Evidence thus suggests that* C. pengoi *may have played a role in the decline of zooplankton abundance in Lake Ontario. It does not appear, however, that zooplankton species richness has been altered as the result of* C. pengoi *invasion (Stewart et al. 2010).*
- *Based on findings in the Baltic Sea and Gulf of Finland, it has been predicted that increased predation pressure on zooplankton caused by increases in* C. pengoi *abundance could lead to an increase in phytoplankton abundance and an eventual shift in the energy fluxes and eutrophication rates in an ecosystem (Litvinchuk and Telesh 2006). In Lake Ontario, Laxson et al. (2003) documented an additional correlation between an increase in chlorophyll* a *concentration and the increase of* C. pengoi *and decrease of herbivorous zooplankton (Laxson et al. 2003). This suggests that* C. pengoi *likely had a significant top-down (albeit variable) effect on zooplankton communities in Lake Ontario, although these predatory effects appear to have declined steadily since the species' establishment (Laxson et al. 2003).*
- *Initial research in southwestern Lake Michigan suggested that* C. pengoi *could have an effect on the food web due to predation of rotifers, whose abundance dropped significantly following* C. pengoi *establishment (Witt et al. 2005). However, this implication is taken with caution, as overall zooplankton abundance had been in steady decline previous to this study (Witt et al. 2005).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1

Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

- *Based on findings in the Baltic Sea and Gulf of Finland, it has been predicted that increased predation pressure on zooplankton caused by increases in* C. pengoi *abundance could lead to an increase in phytoplankton abundance and an eventual shift in the energy fluxes and eutrophication rates in an ecosystem (Litvinchuk and Telesh 2006). In Lake Ontario, Laxson et al. (2003) documented an additional correlation between an increase in chlorophyll* a *concentration and the increase of* C. pengoi *and decrease of herbivorous zooplankton (Laxson et al. 2003). This suggests that* C. pengoi *likely had a significant top-down (albeit variable) effect on zooplankton communities in Lake Ontario, although these predatory effects appear to have declined steadily since the species' establishment (Laxson et al. 2003).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**7**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	**<u>High</u>**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

- Cercopagis pengoi *fouls fishing lines, which acts both as a nuisance and as a possible mechanism of its dispersal and expansion. In a study by Jacobs and MacIsaac (2007), fouling was found to be most intense with longer lines and larger trolling distances; accumulation of* C. pengoi *on a single fishing line towed 1 km in Lake Ontario was as high as 1,024 individuals and 106 diapausing eggs. Lines specially designed to reduce waterflea fouling experienced diminished* C. pengoi *accumulation (Jacobs and MacIsaac 2007).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**1**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6

It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

- *It is possible that* C. pengoi *could benefit planktivorous fish by preying on smaller zooplankton, which are difficult for fish to catch, and storing this energy in a larger body mass, which is easier for fish to prey upon. However, this potential benefit is likely insignificant (Vanderploeg et al. 2002).*

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Cyclops strenuus*

Common Name: Oarsman

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- Cyclops strenuus *is a host to many different parasites in its native range, including the cestodes* Diphyllobothrium *spp. and* Triaenophorus crassus*, the latter of which is capable of infecting whitefish (*Coregonus *spp.), pike (*Esox lucius*) and salmonids (e.g.,* Salvelinus umbla*) (Achleitner et al. 2009). It is also a known host of the eel tapeworm* Bothriocephalus claviceps*; the eel swimbladder nematodes* Anguillicola *spp.; the tapeworms* Proteocephalus torulosus *and* P. neglectus*; the acanthocephalid worm* Pallisentis nagpurensis*; and the helminth* Traienophorus nodulosus *(Dorucu 1999, George and Nadakal 1983, Moravec et al. 1994a, 1994b, Nagasawa et al. 1994, Pulkkinen et al. 2000, Scholz 1991, 1993, 1997, Sysoev 1982).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	**1**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1√
Not significantly	0
Unknown	U

- Cyclops strenuus *is an intermediate host of the cestode parasites* Diphyllobothrium *spp., which also infect commercially and recreationally important fish species such as salmonids (e.g., brown trout* Salmo trutta *and rainbow trout* Oncorhynchus mykiss*) (Dorucu et al. 1995).*
- *Through the consumption of raw or undercooked fish,* Diphyllobothrium *spp. can also infect humans, causing diphyllobothriasis in the digestive system (USFDA 2009). Although this disease can affect 20 million people annually, it is considered rare in the United States and is not thought to be present in the Great Lakes region currently (Scholz et al. 2009, USFDA 2009).*

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √

Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**1**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Daphnia galeata galeata*

Common Name: Waterflea

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

- *It is possible that hybrid clones of* D. g. mendotae *x* D. g. galeata *are more vigorous and fit than parent clones, especially in periods of environmental stress. This could have led to rapid expansion of the hybrid population, especially in parts of Lake Erie (Taylor and Hebert 1993).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level	1 √

AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U

- *After* D. g. galeata *was introduced to Lake Erie it rapidly hybridized with native* D. g. mendotae*. Hybrid clones are now common, especially during the summer months in Lake Erie (Taylor and Hebert 1993).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	**1**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**

Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6

Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Daphnia lumholtzi*

Common Name: Waterflea

Environmental: Unknown
Socio-Economic: Low
Beneficial: Unknown

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U√

- *In competitive experiments between* D. lumholtzi *and Great Lakes native* D. pulex*, Dobberfuhl and Elser (2002) found that in tanks with mixed populations,* D. lumholtzi *productivity dropped to 55% of its control value, while* D. pulex *productivity dropped to just 17% of its control value. Combined productivity of the daphnids dropped by over 50%, indicating that the presence of* D. lumholtzi *could facilitate competitive exploitation and have adverse impacts on overall productivity of the zooplankton community.*
- *Research by Dzialowski (2010) suggests that some* Daphnia *species are more vulnerable to competition with* D. lumholtzi *(e.g.,* D. parvula *and* Ceriodaphnia dubia *were more affected than* D. magna*).*
- *By occupying a niche that was previously unexploited by* Daphnia *spp.,* D. lumholtzi *has been hypothesized to compete with non-daphnid zooplankton (Dzialowski et al. 2000). One such zooplankter is* Diaphanasoma*, whose population size was significantly lower in Kansas reservoirs following* D. lumholtzi *invasion (Dzialowski et al. 2000).*
- *In situ research comparing native* Daphnia *spp. to the exotic* D. lumholtzi *has found that competition between these species is lower than expected.* Daphnia lumholtzi *is a tropical species and is adapted to warmer temperatures than native North American* Daphnia*. Thus,* D. lumholtzi *population sizes tend to increase in late summer when native* Daphnia *populations have been historically low. As a result,* D. lumholtzi *may be filling a vacant "temporal niche" in the warmer summer months (Dzialowski et al. 2000, East et al. 1999, Goulden et al. 1995, Johnson and Havel 2001, Work and Gophen 1999).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6

Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

- *If* D. lumholtzi *outcompetes native zooplankton populations during their normal peak abundance in late summer, this may adversely impact planktivorous fish relying on that critical food source but unable to tolerate* D. lumholtzi*'s spines. Larval and juvenile stages of fish are more likely to be unable to consume* D. lumholtzi *due to gape (mouth-size) limitation (Kolar and Wahl 1998).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- *Soeken-Gittinger et al. (2009) found that the density of* D. lumholtzi *in some parts of the Illinois River was larger than the density of all other native zooplankton combined. High densities appeared to be correlated with high temperatures and increased inorganic sediment suspension, suggesting that areas in the Great Lakes with these conditions could face the greatest impacts (Soeken-Gittinger et al. 2009).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impacts Total	**0**

Total Unknowns (U)	**4**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

- *Potential effects on recreational species remain uncertain.*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

<u>BENEFICIAL EFFECT</u>

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1√
Not significantly	0
Unknown	U

- *This species is a common research subject, as scientists have been able to track its spread since establishment and to evaluate factors of its invasion success (Havel and Herbert 1993, Havel and Medley 2006, Havel et al. 2005, Work and Gophen 1999).*
- *It has also been studied for its unique ability to proliferate during high cyanobacterial growth, a time when few other daphnids are present (Pattinson et al. 2003, Semyalo et al. 2009).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

- *Silverside (*Menidia beryllina*) may be able to utilize this new prey item and survive longer during its late summer spawning period (Leinesch and Gophen 2001).*
- *Leinesch and Gophen (2001) noted that when juvenile fish attain a size capable of consuming* D. lumholtzi*, the fish can grow more rapidly and more easily avoid predation. This is particularly advantageous during the summer months, when* D. lumholtzi *presents itself as a larger prey item than would otherwise occur in the zooplankton.*

Beneficial Effect Total	**1**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact

>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

Scientific Name: *Echinogammarus ischnus*

Common Name: Scud

Environmental: Moderate
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

- Echinogammarus ischnus *has been found to host a parasitic water mold (oomycete) in the St. Lawrence River. This oomycete also parasitizes the Great Lakes native amphipod* Gammarus fasciatus*, but the effects are less severe (Kestrup et al. 2011b).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

- *Following its initial establishment,* E. ischnus *became one of the most abundant non-dreissenid benthic invertebrates in the Lake Ontario, Lake Michigan, and Lake Erie watersheds, where it locally displaced the native amphipod* Gammarus fasciatus *from many sites (Dermott et al. 1998, Haynes et al. 2005, Limén et al. 2005, Nalepa et al. 2001, Ratti and Barton 2003, Stewart et al. 1998a, 1998b, van Overdijk et al. 2003). It has been hypothesized that such displacement is partially due to competition for resources (González and Burkhart 2004, Kestrup and Ricciardi 2009b, Limén et al. 2005, Palmer and Ricciardi 2005, Witt et al. 1997).*
- *A mechanism for competitive exclusion of* G. fasciatus *by* E. ischnus *is less clear and may be influenced by total or relative amphipod densities (Kestrup and Ricciardi 2009a, van Overdijk et al. 2003) or by differences in the physical environment (Palmer and Ricciardi 2004).*
- *For instance, the initial replacement of* G. fasciatus *by* E. ischnus *occurred in primarily rocky and dreissenid-covered habitats, while* G. fasciatus *populations continued to persist on algal and macrophyte-covered substrates (Dermott et al. 1998, Duggan and Francoeur 2007). These two amphipod species may also differ in their responses to abiotic factors such as current velocity or pH, which could affect their relative fitness in different environments (Palmer and Ricciardi 2004).* Echinogammarus ischnus *typically numerically dominates high flow sites, and its abundance in the St. Lawrence River has been more positively correlated with current velocity than with any other physical attribute (Palmer and Ricciardi 2004). Kang et al. (2007) also encountered* E. ischnus *more frequently at high energy coastal sites throughout the Great Lakes.*
- *It has been suggested that* E. ischnus *has potentially benefited from a co-evolved relationship with*

dreissenid mussels (Ricciardi and MacIsaac 2000). Available nutrition from mussel biodeposits, in combination with the structural complexity of Dreissena *mussel substrate, may have given* E. ischnus *a competitive advantage, stimulating its population expansion in the lower Great Lakes (van Overdijk et al. 2003). However, at some sites, native amphipods have been found to consume more* Dreissena *pseudofeces than* E. ischnus *(González and Burkhart 2004). Furthermore, carbon isotopic composition data indicated that the diets of* E. ischnus *and native Great Lakes amphipod* G. fasciatus *differ, suggesting that competition for food is an unlikely mechanism of the species replacement (Limén et al. 2005).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1 √
Not significantly	0
Unknown	U

- *Following its initial establishment,* E. ischnus *became one of the most abundant non-dreissenid benthic invertebrates in the Lake Ontario, Lake Michigan, and Lake Erie watersheds, where it locally displaced the native amphipod* Gammarus fasciatus *from many sites (Dermott et al. 1998, Haynes et al. 2005, Limén et al. 2005, Nalepa et al. 2001, Ratti and Barton 2003, Stewart et al. 1998a, 1998b, van Overdijk et al. 2003). It has been hypothesized that such displacement is partially due to intraguild predation (González and Burkhart 2004, Kestrup and Ricciardi 2009b, Limén et al. 2005, Palmer and Ricciardi 2005, Witt et al. 1997).*
- *Studies in the St. Lawrence River have shown that* E. ischnus *and* G. fasciatus *are mutual (intraguild) predators.* Echinogammarus ischnus *is generally the superior predator of adult gammarids in waters of higher conductivity (Kestrup and Ricciardi 2009b), but this advantage is offset by* G. fasciatus *preying more efficiently on* E. ischnus *juveniles (Kestrup et al. 2011a).*
- *Research in central Europe also reports the invasive* E. ischnus *to be a stronger predator over native gammarids in cases of intraguild predation, suggesting that predation is a probable mechanism of species replacement (Kinzler and Maier 2003).*
- *It is possible that* E. ischnus *evades predators more easily than* G. fasciatus*, particularly on dreissenid-covered substrate (González and Burkhart 2004). In laboratory feeding trials,* G. fasciatus *was more heavily consumed by yellow perch (*Perca flavescens*) and round goby (*Neogobius melanostomus*) on dreissenid-covered substrate than* E. ischnus*, while* E. ischnus *was consumed more heavily on macrophyte beds (González and Burkhart 2004). In contrast, other studies have found no difference between the two species in their vulnerability to predation on dreissenid-covered substrate (Kestrup and Ricciardi 2009a, Palmer and Ricciardi 2005).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**2**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact

>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Eubosmina coregoni*

Common Name: Waterflea

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √

Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- *In the Great Lakes it can reach densities of around 69,000 individuals m^{-2} in western Lake Erie and around 44,500 individuals m^{-2} in Lake Ontario. It has also been recorded at high densities in the fall in Lake Ontario and Lake Michigan (Barbiero et al. 2001, Geller and Müller 1981, Johannsson and O'Gorman 1991, Roth and Stewart 1973). Such high densities could suggest impacts on the abiotic environment.*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

- *In the Great Lakes it can reach densities of around 69,000 individuals m^{-2} in western Lake Erie and around 44,500 individuals m^{-2} in Lake Ontario. It has also been recorded at high densities in the fall in Lake Ontario and Lake Michigan (Barbiero et al. 2001, Geller and Müller 1981, Johannsson and O'Gorman 1991, Roth and Stewart 1973). Such high densities could suggest impacts on the abiotic environment.*

Environmental Impact Total	**0**
Total Unknowns (U)	**4**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1

Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1 √
Not significantly	0
Unknown	U

- *When congregated at the surface of Lake Michigan*, E. coregoni *is an important food item for such fish species as bloater (*Coregonus hoyi*) (Crowder and Crawford 1984).*

Beneficial Effect Total	**1**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Eubosmina maritima*

Common Name: Waterflea

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √

Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	**0**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1

Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring

Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Eurytemora affinis*

Common Name: Oarsman

Environmental: Unknown
Socio-Economic: Unknown
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- Eurytemora affinis *has the ability to feed on toxic cyanobacteria and dinoflagellates (*Dinophysis *spp.) (Engström et al. 2000, Setälä et al. 2009). While these do not appear to be their preferred food source, consumption of toxic phytoplankton results in the buildup of toxins in zooplankton tissue and feces, which consequently can accumulate in benthic organisms, fish, and organisms further up the food chain (Engström et al. 2000, Lehtiniemi et al. 2002, Setälä et al. 2009).*
- Eurytemora affinis *is a probable host and vector for plerocercoids that can infect striped bass in the Sacramento-San Joaquin Estuary (Arnold and Yue 1997).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

- *Because* E. affinis *has become an abundant grazer in parts of the Great Lakes, it is possible that it has had important impacts on the food web (Lee et al. 2007).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

- *Because* E. affinis *has become an abundant grazer in parts of the Great Lakes, it is possible that it has had* *important impacts on the food web (Lee et al. 2007).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**5**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**

1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

- *Outbreaks of cholera are sometimes correlated with copepods, which are common hosts of* Vibrio cholerae *(Colwell 2004, Lee et al. 2007, Piasecki et al. 2004).* Eurytemora *spp. are known to host* V. cholerae *and are the most common of known copepod hosts in the Chesapeake Bay, where this has been studied (Colwell 2004).*
- Eurytemora affinis *has the ability to consume cyanobacteria and other toxic algal blooms; studies in the Baltic Sea indicate that this is likely an important mechanism of the biomagnification of toxins in organisms of economic importance, such as shrimp and fish (Engström et al. 2000, Karjalainen et al. 2008, Setälä et al. 2009).*

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- Eurytemora affinis *has the ability to consume cyanobacteria and other toxic algal blooms; studies in the Baltic Sea indicate that this is likely an important mechanism of the biomagnification of toxins in organisms of economic importance, such as shrimp and fish (Engström et al. 2000, Karjalainen et al. 2008, Setälä et al. 2009).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**3**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

- Eurytemora affinis *could be a significant prey item for fish and other planktivores. Thorp and Casper (2003) demonstrated such potential in an enclosure experiment with yellow perch (*Perca flavescens*) in the St. Lawrence River; 99% of* E. affinis *disappeared from fish enclosures, presumably due to predation.*

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Gammarus tigrinus*

Common Name: Amphipod

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

- *This species can act as an intermediate host to the acanthocephalan* Paratenuisentis ambiguus, *whose definitive host is* Anguilla rostrata *(Samuel and Bullock 1981).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

- *There is a potential for* G. tigrinus *to exert negative impacts on the native Great Lakes amphipod community resulting from predation and competition (Dick 1996, Grigorovich et al. 2005).*
- *While* G. tigrinus *can exclude* C. pseudogracilis *from habitats with good water quality, in poor water quality habitats, this may not be the case (MacNeil et al. 2001).*
- *Increased mortality in the Baltic Sea native amphipod,* G. salinus*, has been attributed to increased competition with* G. tigrinus *over* Pilayella littoralis*, a mutually-grazed macrophyte species (Orav-Kotta et al. 2009).*
- *The central European invasion of* G. tigrinus *has been accompanied by elimination of some native amphipod species from parts of the Rhine River, the Baltic Sea, and several waterbodies in the Netherlands. It is frequently a superior predator compared to native amphipods and could possibly have a reproductive advantage over such indigenous species as* G. duebeni*,* G. zaddachi*, and* G. pulex *(Grigorovich et al. 2005, Pinkster et al. 1977).*
- *In Ireland, the native opossum shrimp* Mysis relicta *has been forced to change its use of microhabitats, exposing itself to increased fish predation, as a result of prey overlap with* G. tigrinus *Bailey et al. 2006).*
- Gammarus tigrinus *also preys on relatively small North American amphipod,* Crangonyx pseudogracilis*, in Ireland and could similarly prey on it in the Great Lakes (Dick 1996, Grigorovich et al. 2005).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any	6

native species populations, creation of a dead end or any other significant alteration in the food web)	
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

- *In the Baltic Sea, the presence of* G. tigrinus *appeared to facilitate fish predation on* G. salinus *in certain habitat types (Kotta et al. 2010).*
- *As a facultative carnivore of other macroinvertebrates,* G. tigrinus *is thought to influence community structure (e.g., trophic relationships) through niche preemption of resources that would normally be consumed by its prey (Savage 2000).*
- *There is a potential for* G. tigrinus *to exert negative impacts on the native Great Lakes amphipod community resulting from predation and competition (Dick 1996, Grigorovich et al. 2005).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**4**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1

Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

- *Quickly following its introduction to rivers in Germany and the Netherlands, reports emerged of extreme cases in which heavy densities of* G. tigrinus *had adverse effects on fishing gear and trapped fish (Pinkster et al. 1977).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

<u>BENEFICIAL EFFECT</u>

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √

Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

- *Great Lakes fish likely consume* G. tigrinus *but this has yet to be studied (H. MacIsaac, pers. comm.; but see list of* Gammarus *spp. fish predators in MacNeil et al. 1999).*

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Hemimysis anomala*

Common Name: Bloody red shrimp

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- *A mysid introduction can increase the biomagnification of contaminants in piscivores through a lengthening of the food chain; for example, concentrations of polychlorinated biphenyls and mercury in fishes have been shown to be higher in lakes containing mysids than in mysid-free lakes (Cabana et al. 1994, cf. Rasmussen et al. 1990).*
- *Through direct transmission and indirect effects on the food web, introduced mysids may cause increased parasitism by nematodes, cestodes, and acanthocephalans in fishes (Lasenby et al. 1986, Northcote 1991).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

- Hemimysis anomala *may compete with, or prey upon, other invertebrate predators, such as* Bythotrephes longimanus *and* Leptodora kindti. *Its omnivory may also reduce local phytoplankton if small-sized juvenile mysids are abundant (Ketelaars et al. 1999).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

- *Based on its impacts in some European reservoirs (Ketelaars et al. 1999),* H. anomala *may reduce* *zooplankton biomass and diversity in invaded areas, with cladocerans, rotifers, and ostracods being most affected.*

- Hemimysis anomala *may compete with, or prey upon, other invertebrate predators, such as* Bythotrephes longimanus *and* Leptodora kindti. *Its omnivory may also reduce local phytoplankton if small-sized juvenile mysids are abundant (Ketelaars et al. 1999).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- Hemimysis *feeds rapidly, even at low prey densities, and its fecal pellets may alter the local physico-chemical environment (Ketelaars et al. 1999, Olenin and Leppäkoski 1999, Pienimäki and Leppäkoski 2004).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- Hemimysis *feeds rapidly, even at low prey densities, and its fecal pellets may alter the local physico-chemical environment (Ketelaars et al. 1999, Olenin and Leppäkoski 1999, Pienimäki and Leppäkoski 2004).*

Environmental Impact Total	**0**
Total Unknowns (U)	**5**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

- *Important fish species could be affected through increased parasitism (Lasenby et al. 1986, Northcote 1991), toxin biomagnification (Cabana et al. 1994, cf. Rasmussen et al. 1990), or trophic web alterations (Ketelaars et al. 1999).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or	6

tourism	
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

- Hemimysis anomala *is considered a high-energy food source due to its lipid content, which can increase growth rates for planktivores (Borcherding et al. 2006). However, the nutritional value of* H. anomala *can vary depending on the food source and trophic position of the individual (Marty et al. 2010). In some lakes, mysid (*Mysis *spp.) introductions have preceded the increased growth of salmonids; in contrast, in other lakes they are associated with rapid declines in abundance and productivity of pelagic fishes (Lasenby et al. 1986, Langeland et al. 1991, Spencer et al. 1991).*
- *Stable isotope analysis suggests that* H. anomala *may be replacing zooplankton in the diet of young yellow perch (Yuille et al. in press). It appears that as* H. anomala *density increases, this species plays a more substantial role in supporting higher trophic levels (Yuille et al. in press).*

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	

0	≥2	Unknown
1	≥1	

Scientific Name: *Heteropsyllus* nr. *nunni*

Common Name: Oarsman

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

- Heteropsyllus *nr.* nunni *has dominated the harpacticoid community in shallow sites (up to 9 m) in Lake Michigan. This may either be due to successful competition with native species for similar resources or the ability to exploit unused resources (Garza and Whitman 2004, Horvath et al. 2001).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level	1

AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	**0**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6

Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √

Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Megacyclops viridis*

Common Name: Oarsman

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

- *As a large carnivorous copepod, it has been noted to feed on fish larvae and could potentially compete with young fish over sources of food such as oligochaetes and other plankton or larval organisms (Fryer 1957).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR	1

It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	**0**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe	1

AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0
Unknown	U √

- *Studies in Eurasia have indicated that* M. virdis*, like other cyclopoid copepods, could act as a biological control agent of certain mosquito larvae, which has implications for dengue fever control in parts of the world (Blaustein and Margalit 1994, Dieng et al. 2002, Fryer 1957).*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6

Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Neoergasilus japonicus*

Common Name: Parasitic oarsman

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *In Saginaw Bay, Lake Huron,* N. japonicus *has most commonly been found infecting pumpkinseed sunfish (*Lepomis gibbosus*), followed in frequency by yellow perch (*Perca flavescens*), rock bass (*Ambloplites rupestris*), bluegill (*Lepomis macrochirus*), carp (*Cyprinus carpio*), channel catfish (*Ictalurus punctatus*), goldfish (*Carassius auratus*), green sunfish (*Lepomis cyanellus*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), and fathead minnow (*Pimephales promelas*) (Hudson and Bowen 2002).*
- *In 2006, eight new hosts of* N. japonicus *were discovered in Saginaw Bay, including bluntnose minnow (*Pimephales notatus*), common shiner (*Luxilus cornutus*), emerald shiner (*Notropis atherinoides*), golden shiner (*Notemigonus crysoleucus*), quillback (*Carpoides cyprinus*), sand shiner (*Notropis stramineus*), spotfin shiner (*Cyprinella spiloptera*), and spottail shiner (*Notropis hudsonius*) (Hudson and Lesko 2011).*
- *In 2011, several specimens of* N. japonicus *were found on green sunfish and bluegill in an Ottawa National Wildlife Refuge wetland of Crane Creek, adjacent to Lake Erie and east of Toledo, Ohio (P. Hudson, pers. comm.).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have	1

not been widespread or severe	
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	**1**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	

0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

- Neoergasilus japonicus *has invaded aquaculture ponds outside of the Great Lakes and has demonstrated the ability to infect many types of farm-raised fish (see fact sheet) (Hayden and Rogers 1998).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

<u>BENEFICIAL EFFECT</u>

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6

It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered species, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Nitokra hibernica*

Common Name: Oarsman

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *The introductions of* N. hibernica *and its nonindigenous congener* N. incerta *are very likely responsible for the introduction of the suctorian ciliate* Acineta nitocrae *to Lake Erie (by* N. hibernica*) and the Detroit River (by* N. incerta*).* Acineta nitocrae *is known to be epizooic on these two copepods in the Ukraine (Grigorovich et al. 2001).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual	1

level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	**1**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**<u>Unknown</u>**
1	≥1	

<u>SOCIO-ECONOMIC IMPACT</u>

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**

Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1

Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

- Nitokra hibernica *has been collected from the stomach of one slimy sculpin (*Cottus cognatus*) in Lake Huron, and rainbow smelt (*Osmerus mordax*) has been known to feed on it in Saginaw Bay, Lake Huron (Hudson and Lesko 2011, Hudson et al. 1998).*

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Nitokra incerta*

Common Name: Oarsman

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *The introduction of* N. incerta *is very likely responsible for the introduction of the suctorian ciliate* Acineta nitocrae *to the Detroit River;* A. nitocrae *is known to be epizooic on this copepod in the Ukraine (Grigorovich et al. 2001).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level	1

AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impacts Total	**1**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6

Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √

Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Salmincola lotae*

Common Name: Parasitic oarsman

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *In Lake Superior,* S. lotae *has been known to cause relatively large lesions where the bulla is implanted in the mouth of* Lota lota*. Around 56% of the host species in the Apostle Islands region have been infected at a given time, with an average of 3.5 parasites per fish (Hudson and Lesko 2011, Lasee et al. 1988).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level	1

AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	**1**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6

Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**

Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1

Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Schizopera borutzkyi*

Common Name: Oarsman

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0√
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U√

- Schizopera borutzkyi *has altered the species composition of nearshore harpacticoid communities, comprising up to 75% of the community at deep sites (15 m) in Lake Michigan. Impact on the food web in these communities is unknown, but it is likely that* S. borutzkyi *is competing with native species for similar resources or has the ability to exploit previously unused resources (Horvath et al. 2001).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual	1

level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	**0**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**

Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1

Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

- Schizopera borutzkyi *could have the ability to exploit previously unused resources (Horvath et al. 2001).*

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Skistodiaptomus pallidus*

Common Name: Oarsman

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

- *Based on evidence from an Ohio lake, it has been suggested that* S. pallidus *is an intermediate host for the parasitic worm* Tanaorhamphus longirostris*, although the study of this occurrence has been limited (Hubschman 1983).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U√

- Skistodiaptomus pallidus *became the primary calanoid copepod in a particularly eutrophic portion of Lake Tahoe, dominating two previously common species,* Leptodiaptomus tyrrelli *and* Epischura nevadensis *(Byron and Saunders 1981).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U√

- Skistodiaptomus pallidus *is an efficient omnivorous predator, with the ability to prey on preferred rotifers and microzooplankton from large distances. It also consumes algae and practices cannibalism, which may allow populations to persist when resource availability is low (Williamson and Butler 1986, Williamson and Vanderploeg 1988).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Environmental Impact Total	**0**
Total Unknowns (U)	**5**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**

1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the	6

natural or cultural character of the area, or significantly reduced the area's value for future generations	
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √

Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

A.7 Mollusks

Scientific Name: *Bithynia tentaculata*

Common Name: Faucet snail

Environmental: High
Socio-Economic: Moderate
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6 √
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

- *The introduction of* B. tentaculata *has been linked to extensive mortality of migratory waterbirds in the Upper Mississippi River National Wildlife and Fish Refuge in Wisconsin due to its role as a host of the trematodes* Cyathocotyle bushiensis *and* Sphaeridiotrema globulus *(Herrmann and Sorensen 2009, Sauer et al. 2007). Between 2002 and 2006, over 20,000 migratory birds died at this location due to these parasites.*
- *Duck (*Anas *spp.) mortality in lower Quebec was credited to these two trematodes and their snail host (Ménard and Scott 1987), as was the death of 6,000-7,000 scaup (*Aythya *spp.) over a two month period at Lake Winnibigoshish in 2007 (Lawrence et al. 2009).*
- *A 1997 mass mortality event of over 10,000 birds (particularly American coot,* Fulica americana, *and lesser scaup,* Aythya affinis*) was reported at Shawano Lake, WI (Cole 2001, Cole and Franson 2006).* Bithynia tentaculata *occurs in this Wisconsin lake, and the deaths were primarily attributed to the presence of* Leyogonimus polyoon*, a third trematode species hosted by* B. tentaculata *(Cole 2001, Cole and Franson 2006).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

- *Between 1917 and 1968, the species richness of mollusks in Oneida Lake, NY decreased by 15% as the faucet snail increased in abundance (Harman 2000). After the introduction of* B. tentaculata *into the Erie Canal, the faucet snail began replacing two pleurocerid species,* Elimia virginica *and* E. livescens *(Jokinen 1992). It is very probable that the faucet snail has particularly impacted pleurocerids due to its higher growth rates (Shiro Tashiro and Colman 1982).*
- *Where the faucet snail has been observed in Lake Champlain, NY, it generally dominates gastropod assemblages (VTDEC and NYDEC 2000).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

- *Laboratory research on the impact of grazing by* B. tentaculata *indicated that it can have complex impacts on the periphyton community (Burgmer et al. 2010). Through direct and indirect effects,* B. tentaculata *grazing contributed to a shift from larger filamentous algae to small prostrate forms, was associated with a significant reduction in the biomass of heterotrophic nanoflagellates and ciliates, and was also linked to a weak decline in meiofauna biomass (Burgmer et al. 2010).*
- *Grazing by* B. tentaculata*, along with another snail species, was correlated with a decline in microalgal species richness (but increased evenness) and a significant reduction in the biomass microalgae, nanoautrophs, and bacteria (Burgmer et al. 2010).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild	1

AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U √

Environmental Impact Total	**7**
Total Unknowns (U)	**4**

Scoring		
Score	# U	Impact
>5	Any	**<u>High</u>**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

<u>SOCIO-ECONOMIC IMPACT</u>

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *Historically, this species has been known to infest municipal water supplies in abundance (Mills et al. 1993). The snail also has the potential to be a bio-fouling organism for underwater intakes and in swimming areas (VTDEC and NYDEC 2000).*

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0

Unknown	U √

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

- *In areas of Wisconsin where the trematode parasites of* B. tentaculata *are causing large die-offs of waterbirds (see Environmental Impact section), these mass mortalities have fueled health concerns among waterfowl hunters and increased the difficulty of hunting game (Sauer et al. 2007).*
- *These mass mortality events have also resulted in restricted recreational access during periods of cleanup (Cole 2001, Lawrence et al. 2009, Sauer et al. 2007*).

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U√

- *In areas of Wisconsin where the trematode parasites of* B. tentaculata *are causing large die-offs of waterbirds (see Environmental Impact section), these mass mortalities have fueled health concerns among waterfowl hunters and increased the difficulty of hunting game (Sauer et al. 2007).*

Socio-Economic Impact Total	**2**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1√
Not significantly	0
Unknown	U

- *The faucet snail has the potential to be a good biomonitor for contaminants such as cadmium, zinc, and methylmercury, owing to well-known correlations between environmental concentrations and snail tissue concentrations of these toxic compounds (Desy et al. 2000, Flessas et al. 2000).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**1**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Cipangopaludina chinensis malleata*

Common Name: Chinese mystery snail

Environmental: Unknown
Socio-Economic: Unknown
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- *Like other mollusks, this introduced species may be a vector for the transmission of parasites and diseases. In the Boston area,* C. chinensis *is a regular host to the common native parasite* Aspidogaster conchicola, *which is a first time record in North America for a gastropod acting as host to this species (Michelson 1970).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

- *In a mesocosm experiment, the presence of* C. chinensis *was correlated with substantial decreases in abundance and/or biomass of native snails* Physa gyrina*,* Lymnaea stagnalis, *and* Helisoma trivolvis*, which the authors primarily attributed to competition for resources (Johnson et al. 2009).*
- *In a survey of Wisconsin lakes, Solomon et al. (2009) found the abundance of native* Lymnaea stagnalis *to be negatively correlated with the abundance of* C. chinensis*, suggesting that* C. chinensis *may be an important driver of competition and native snail displacement on the community-scale.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

- *Where* C. chinensis *overlaps with the introduced rusty crayfish,* Orconectes rusticus*, impacts on native populations may be particularly severe. The relatively large and thick shell of C. chinensis reportedly enables this species to evade predation by* O. rusticus *more easily than native snails; thus, the risk of predation by* O. rusticus *remains relatively high while competition with* C. chinensis *add further pressure on native snail survival (Johnson et al. 2009).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- *At the community level,* C. chinensis *presence was correlated with a decline in periphyton levels, particularly on the sediment, and an increased nitrogen:phosphorus ratio in the water column. Further analysis suggested that higher levels of phosphorous uptake in* C. chinensis *tissue and reduced phosphorous levels in* C. chinensis *excrement relative to native snails is a plausible explanation for the latter observation, which suggests that this species may provide a phosphorous sink in invaded ecosystems (Johnson et al. 2009).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- *In a community-scale mesocosm experiment,* C. chinensis *presence was correlated with a decline in periphyton levels, particularly on the sediment (Johnson et al. 2009).*

Environmental Impact Total	**0**
Total Unknowns (U)	**5**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

- Cipangopaludina chinensis *is also a known host of parasites in its native range, at least one of which (*Echinostoma cinetorchis*, an intestinal trematode that causes echinostomiasis) is capable of infecting humans through ingestion of uncooked snails (Chung and Jung 1999, Graczyk and Fried 1998). However, no related cases of infection are currently known from the Great Lakes region. The global significance of host activity by* C. chinensis *in facilitating parasitization of humans is unknown.*

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- *The Chinese mystery snail has the ability to clog screens of water intake pipes, causing difficulties for water treatment plants, but the extent of this occurrence in the Great Lakes is unknown*

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1

Not significantly	0
Unknown	U √

- *It is known to exist in the aquarium and live food trade (Cordiero 2002, Havel 2010, Karatayev et al. 2009, Mackie 2000a, Mills et al. 1993), but the extent of this in the Great Lakes is unknown.*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

- *While not currently applied in the Great Lakes,* Corbicula *spp. have the potential to be used as a bioindicator for organochlorine pesticides persisting in the environment (Takabe et al. 2011) .*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**

1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Cipangopaludina japonica*

Common Name: Japanese mystery snail

Environmental: Unknown
Socio-Economic: Unknown
Beneficial: Unknown

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

- *In Spot Pond, Massachusetts, the Japanese mystery snail was discovered to be a regular host to the common native parasite* Aspidogaster conchicola*, marking the first record for a gastropod host of this species in North America (Michelson 1970).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U√

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level	1

AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Environmental Impact Total	**0**
Total Unknowns (U)	**5**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6

Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

- *The Japanese mystery snail is a host to* Angiostrongylus cantonensis *larvae in Taiwan, a species associated with eosinophilic meningitis (Lin and Chen 1980). It is also capable of hosting many other parasites in Asia, some of which may infect humans. The extent of this species' role as a host to parasites in the Great Lakes is unknown.*

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- *Reports of* C. chinensis *clogging water intakes have emerged, suggesting that closely related* C. japonica *may also be capable of damaging infrastructure, particularly given the high densities which have been encountered by fishermen in the past (Wolfert and Hiltunen 1968).*

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

- *In the past, this species has been caught in large numbers by commercial fishermen in Sandusky Bay, Lake Erie, where two tons catches have sometimes been reported in one seine haul (Wolfert and Hiltunen 1968). It could become a similar nuisance in other areas with dense populations (Wolfert and Hiltunen 1968).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**3**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0
Unknown	U√

- *Mystery snails (*Cipangopaludina spp.*) have been popular aquarium species in the U.S., and their role in the aquarium/ornamental market is often invoked as the primary explanation of these species' widespread dispersal (Cordiero 2002, Havel 2010, Karatayev et al. 2009, Mackie 2000a, Mills et al. 1993).* Cipangopaludina *spp. have also had presence in live food markets, particularly in Asian markets of the Western U.S. (Mackie 2000a).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0
Unknown	U √

- *Research in Japanese rice paddies suggested that the feeding activity of* C. japonica*, a common rice paddy dweller and consumer of bacteria, could be used to assimilate excess sewage from wastewater treatments if the sewage were applied as compost (Kurihara and Kadowaki 1988). However, utilizing* C. japonicus *in such a way could pose a danger to consumers of the snail, including humans, due to the potential accumulation of heavy metals and other toxic substances (Kurihara and Kadowaki 1988).*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	<u>**Unknown**</u>
1	≥1	

Scientific Name: *Corbicula fluminea*

Common Name: Asian clam

Environmental: Moderate
Socio-Economic: Moderate
Beneficial: Unknown

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0√
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U√

- Corbicula fluminea *may filter a wider range of food sources at a faster rate than native fresh water mussels, which could decrease food availability for other benthic and pelagic species (Atkinson et al. 2010, Strayer 1999, Vaughn and Hakencamp 2001).*
- *Results by Silverman et al. (1997) found that* C. fluminea *are capable of filter-feeding* E. coli *and other bacteria at a higher rate than some native unionid mussels. A number of experiments analyzing the impact of* C. fluminea *on native bivalves have documented conflicting results, from competitive exclusion to coexistence (see Sousa et al. 2005, Strayer 1999).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *Cohen et al. (1984) documented a reduction in phytoplankton abundance by 40-60% in a roughly 7 km stretch of the Potomac River, MD, relative to upstream and downstream segments. This was likely due to the very high densities of* C. fluminea *in this stretch (an increase from 1.2 clams/m^2 in 1977 to 1,467 clams/m^2 in 1981) and the high filter feeding rates that were observed (Cohen et al. 1984).*
- *Higher levels of nitrogen, ammonia (NH_3), and orthophosphate (PO_4) in feces and pseudofeces, as well as the chemical releases following* C. fluminea *summer die-offs, could alter nutrient cycling in freshwater systems (Atkinson et al. 2010, Lauritsen and Mozley 1989).*
- *Microcosm experiments suggest that this clam can increase sediment oxygen uptake, as well as the release of soluble reactive phosphorus, ammonium, and nitrate (Zhang et al. 2011).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *Cohen et al. (1984) documented a reduction in phytoplankton abundance by 40-60% in a roughly 7 km stretch of the Potomac River, MD, relative to upstream and downstream segments. This was likely due to the very high densities of* C. fluminea *in this stretch (an increase from 1.2 clams/m^2 in 1977 to 1,467 clams/m^2 in 1981) and the high filter feeding rates that were observed (Cohen et al. 1984).*
- *Following the introduction of* C. fluminea *to the Potomac River Estuary, a series of ecosystem-level changes appeared to occur, including increased water clarity followed by growth of fish, bird, and submerged aquatic plant populations, all of which evidently reversed with the decline of* C. fluminea *populations (Phelps 1994).*
- *Due to its ability to both filter feed and pedal feed, it can alter the abundance of organic matter in the sediment depending on its primary source of food at a given time (Hakencamp and Palmer 1999).*
- *Higher levels of nitrogen, ammonia (NH_3), and orthophosphate (PO_4) in feces and pseudofeces, as well as*

the chemical releases following C. fluminea *summer die-offs, could alter nutrient cycling in freshwater systems (Atkinson et al. 2010, Lauritsen and Mozley 1989)*

Environmental Impact Total	**2**
Total Unknowns (U)	**2**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1√
Not significantly	0
Unknown	U

- *Large numbers of* C. fluminea, *either dead or alive, clog water intake pipes, and the cost of removing them has been estimated at about a billion dollars each year in the United States (Pimentel et al. 2000).*
- *Juvenile* C. fluminea *get carried by water currents into condensers of electricity generating facilities, where they attach themselves to the walls via byssus threads, growing and ultimately obstructing the flow of water. They can also increase sedimentation rates within pipes and canals (McMahon 2000).*
- *Several nuclear reactors have had to be closed down temporarily in the United States for the removal of* Corbicula *from the cooling systems (Isom 1986).*
- *In Ohio and Tennessee where river beds are dredged for sand and gravel for use as aggregation material in cement, high densities of* C. fluminea *have incorporated themselves in the cement, burrowing to the surface as the cement starts to set and weakening its structure (Sinclair and Isom 1961).*

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *In Ohio and Tennessee where river beds are dredged for sand and gravel for use as aggregation material in cement, the high densities of* C. fluminea *have incorporated themselves in the cement, burrowing to the surface as the cement starts to set and weakening the structure (Sinclair and Isom 1961).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**2**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

- *While not currently applied in the Great Lakes,* Corbicula *spp. has the potential to serve as a bioindicator for organochloride pesticides in the environment (Takabe et al. 2011).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0
Unknown	U √

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1 √
Not significantly	0
Unknown	U

- *The presence of* C. fluminea *shells in otherwise soft substrate has been correlated with an increase in* *arthropod and mayfly (*Caenis *spp.) densities (Karatayev et al. 2005, Werner and Rothhaupt 2007, 2008).*

- Corbicula fluminea *is consumed mainly by fish and crayfish. Outside of the Great Lakes, scientists found that several fish species modified their diet to feed on* C. fluminea *and other molluscan invaders.*

Beneficial Effect Total	**1**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

Scientific Name: *Dreissena bugensis*

Common Name: Quagga mussel

Environmental: High
Socio-Economic: High
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *Quagga mussels accumulate organic pollutants within their tissues to levels more than 300,000 times greater than concentrations in the environment, and these pollutants are also found in their pseudofeces (Snyder et al. 1997).*
- *Pollutants can be passed up the food chain, increasing wildlife exposure to organic pollutants, such as PCBs and hexachlorobenzine, and potentially mercury (Mueting and Gerstenberger 2010, Richman and Somers 2010, Snyder et al. 1997).*
- *Declines in* Diporeia *spp., another benthic invertebrate, have been highly correlated with dreissenid expansion, potentially due to reductions in phytoplankton abundance (an important food source) or through the introduction of toxins and pathogens associated with dreissenids and their waste products (Fahnenstiel et al. 2010, Nalepa et al. 2006, Watkins et al. 2007).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6 √
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U

- *Declines in* Diporeia *spp., another benthic invertebrate, have been highly correlated with dreissenid expansion, potentially due to reductions in phytoplankton abundance (an important food source) or through the introduction of toxins and pathogens associated with dreissenids and their waste products (Fahnenstiel et al. 2010, Nalepa et al. 2006, Watkins et al. 2007).*
- *Likely correlated to declining late winter phytoplankton blooms and chlorophyll* a *concentrations in Lake Michigan from 2001 to 2008, there was a reported decline in cyclopoid and omnivorous calanoid copepod populations over this period (Kerfoot et al. 2010).*
- *Spring phytoplankton biomass and primary production in Lake Michigan decreased 87% and 70%, respectively, from 1995-98 to 2007-08 (Fahnenstiel et al. 2010). This could result in increased competition among planktivorous species.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6 √
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U

- *Declines in* Diporeia *spp., another benthic invertebrate, have been highly correlated with dreissenid expansion (Fahnenstiel et al. 2010, Nalepa et al. 2006, Watkins et al. 2007).* Diporeia *is an important prey item linking the benthos to higher trophic levels, and it has been suggested that the shift from* Diporeia *to* Dreissena *has transformed the benthic community into an energy sink which may no longer support the upper food web (Nalepa et al. 2009).*
- *Quagga mussels likely decrease food availability for zooplankton through their rapid filtration of phytoplankton, thereby altering the food web.*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6 √
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

- *In Lake Michigan, the fraction of water column cleared (FC) was measured experimentally for quagga mussels in 2007-2008 and determined to exceed the phytoplankton growth rate at depths of 30-50 m, likely by a factor of five (Vanderploeg et al. 2010). This excessive filtration is hypothesized to cause a mid-depth sink of carbon and phosphorous; this is similar to the nearshore phosphorous shunt caused by zebra mussels, except that it occurs at mid-depth levels where quagga mussel densities are high (Vanderploeg et al. 2010).*
- *In Lake Michigan, total phosphorus (TP) and mean chlorophyll* a *concentrations both markedly fell in spring seasons after the expansion of quagga mussels, and TP levels remained low into summer (Mida et al. 2010). Dramatic increases in summer silica were initiated in the early 2000s in Lake Huron and in 2004 in Lake Michigan and seem to be associated with the expansion of quagga mussel populations in the lakes at those times (Evans et al. 2011).*
- *Lake Michigan water transparency, which ranged from 74-85% at deepwater sites in 2001, increased to 94-96% in 2008 following quagga mussel expansion (Kerfoot et al. 2010).*

- *High water filtration rates and high dreissenid abundances have also lead to the accumulation of pseudofeces (Claxton et al. 1998). Through nitrogen and phosphorus remineralization, the production of biodeposits may increase and redirect nutrient supply and turnover in colonized areas (Conroy et al. 2005, Hecky et al. 2004).*
- *When high-density dreissenid colonies form, nitrate (NO_3^-) concentrations may significantly increase in the interstitial water at the colony base while dissolved oxygen concentrations drop, creating potentially detrimental conditions for some benthic organisms (Burks et al. 2002). Concurrently, dreissenid metabolic activity may lower the nitrogen:phosphorus ratio in the water column, which (along with selective feeding behavior of dreissenids) appears to favor the growth of toxic cyanobacteria (*Microcystis *spp.) (Bykova et al. 2006).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6 √
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

- *Quagga mussels are filter-feeders and at high abundances remove substantial amounts of phytoplankton and suspended particulates from the water. Spring phytoplankton biomass and primary production, which can be primarily attributed to diatoms, decreased 87% and 70%, respectively, in Lake Michigan from 1995-98 to 2007-08 (Fahnenstiel et al. 2010).*
- *While diatoms previously accounted for >50% of phytoplankton composition at the deep chlorophyll layer, they composed less than 5% of it in 2007-08 (Fahnenstiel et al. 2010).*
- *Conditions in Lake Michigan, especially in the critical late winter to spring season, indicate that the southern basin is transforming into a more oligotrophic condition, similar to that of Lake Superior in terms of levels of nutrients, chlorophyll, and primary production (Mida et al. 2010).*
- *Increasing amounts of pseudofeces and biodeposits could also have an impact on multiple trophic levels via changes to the physical environment. A current study in Brocton Shoal, Lake Erie, suggests that colonization of lakebed areas by dreissenid mussels and the consequent filling of remaining interstitial spaces with pseudofeces and fine-grained sediments may significantly eliminate valuable habitat native habitat (S. Mackey, pers. comm.). Brocton Shoal, once thought to be an important area for lake trout spawning, appears to have diminished suitability as a spawning ground, potentially due to such impacts (S. Mackey, pers. comm.).*

Environmental Impacts Total	**25**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	

0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6 √
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

- *Although* D. bugensis *lacks the keeled shape that allows* D. polymorpha *to attach so tenaciously to hard substrata, it is able to colonize both hard and soft benthic habitats (Mills et al. 1996). These major biofouling organisms can clog water intake structures, such as pipes and screens, thereby reducing pumping capabilities for power and water treatment plants and financially impacting industries, companies, and communities (Connelly et al. 2007).*
- *Colonization has occurred at the Hoover, Imperial, Davis, and Parker Dams on the Lower Colorado River, causing various degrees of clogging and subsequent expense (Claudi and Prescott 2007a, b).*

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *The reemergence of nuisance algal species* Cladophora *in Lake Ontario, Lake Erie, and Lake Michigan has been largely attributed to the resulting changes in nutrient cycling and water clarity due to zebra mussels (Auer et al. 2010, Hecky et al. 2004). Similar observed effects between zebra and quagga mussel filtration suggest that quagga mussels could also contribute to this impact.*

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6 √
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

- *The quagga mussel has the potential to cause major costs for dams and the hydropower industry, particularly if its westward expansion continues. Colonization has already resulted in clogging and subsequent expense at the Hoover, Imperial, Davis, and Parker Dams on the Lower Colorado River (Claudi and Prescott 2007a, b).*
- *Reductions in plankton biomass may cause increased competition, decreased survival and decreased biomass of planktivorous fish, including commercially important species.*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

- *Recreation-based industries and activities have also been impacted by* Dreissena*'s biofouling ability; docks, breakwalls, buoys, and boats have all been heavily colonized and beaches have been incidentally littered with dead shells. The extent of negative impacts on recreation due to quagga mussels' ability to colonize both hard and soft substrates is as of yet unclear.*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6 √
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U

Socio-Economic Impact Total	**20**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	**<u>High</u>**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

<u>BENEFICIAL EFFECT</u>

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

- *Quagga mussels have been proposed and tested for use as bio-indicators (both in the Great Lakes and Western U.S.) due to their ability to accumulate toxins and metals at much higher levels than those found in the environment, especially when small environmental levels are difficult, and yet important, to measure (Mueting and Gerstenberger 2010, Richman and Somers 2010). For instance, the National Oceanic and Atmospheric Administration's Mussel Watch program has been monitoring contaminants in Great Lakes dreissenids since the early 1990s.*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1 √
Not significantly	0
Unknown	U

- *Increased water clarity following dreissenid introduction is perceived as a benefit by some, especially business owners and residents on invaded water bodies (Limburg et al. 2010).*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**1**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Dreissena polymorpha*

Common Name: Zebra mussel

Environmental: High
Socio-Economic: High
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6√
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

- *Biomagnification of polychlorinated biphenyls (PCBs) was observed in* Gammarus *amphipods associated with zebra mussels, indicating concentration of pollutants in zebra mussel feces or pseudofeces can transfer to other trophic levels (Bruner et al. 1994).*
- *Biomagnification of toxic contaminants through the food web is another concern of zebra mussel invasion, especially because mussel predation by round goby* Neogobius melanostomus *has provided a link between* Dreissena *and higher trophic levels (Hanari et al. 2004, Jude et al. 2010).*
- *Declines in* Diporeia *spp., another benthic invertebrate, have been highly correlated with dreissenid expansion, potentially due to reductions in phytoplankton abundance (an important food source) or through the introduction of toxins and pathogens associated with dreissenids and their waste products (Fahnenstiel et al. 2010, Nalepa et al. 2006, Watkins et al. 2007).*
- *Like other mollusks,* D. polymorpha *is capable of hosting a variety of parasites, although the parasite load varies across its introduced range and appears to be lower in North America (Mastitsky et al. 2010). In particular,* D. polymorpha *acts as an intermediate host of the trematode Bucephalus polymorphus, which has caused pathologies and mortalities in cyprinids across parts of Europe (Molloy et al. 1997).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6 √
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U

- *At a 90% efficiency rate, zebra mussels are much more efficient at filtering small particles than are unionids (Noordhuis et al. 1992). Bacteria, which* D. polymorpha *also tend to filter more quickly than native unionids, may represent another important food source (Cotner et al. 1995, Silverman et al. 1996, Silverman et al. 1997).*
- *Zooplankton abundance dropped 55-71% following mussel invasion in Lake Erie, with microzooplankton more heavily impacted (MacIsaac et al. 1995). Mean summer biomass of zooplankton decreased from 130 to 78 mg dry wt. m^{-3} between 1991 and 1992 in the inner portion of Saginaw Bay. The total biomass of zooplankton in the Hudson River declined 70% following mussel invasion, due both to a reduction in large zooplankton body size and a reduction in microzooplankton abundance. These effects can be attributed to*

reduction of available food (phytoplankton) and direct predation on microzooplankton.

- *Reductions in zooplankton biomass may cause increased competition, decreased survival, and decreased biomass of planktivorous fish.*
- *Declines in* Diporeia *spp., another benthic invertebrate, have been highly correlated with dreissenid expansion, potentially due to reductions in phytoplankton abundance (an important food source) or through the introduction of toxins and pathogens associated with dreissenids and their waste products (Fahnenstiel et al. 2010, Nalepa et al. 2006, Watkins et al. 2007).*
- *Other effects include the extirpation of native unionid clams through epizootic colonization (Baker and Hornbach 1997, Schloesser et al. 1996). Zebra mussels restrict valve operation, cause shell deformity, smother siphons, compete for food, impair movement, and deposit metabolic waste onto unionid clams.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6 √
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U

- *Zooplankton abundance dropped 55-71% following mussel invasion in Lake Erie, with microzooplankton more heavily impacted (MacIsaac et al. 1995). Mean summer biomass of zooplankton decreased from 130 to 78 mg dry wt. m^{-3} between 1991 and 1992 in the inner portion of Saginaw Bay. The total biomass of zooplankton in the Hudson River declined 70% following mussel invasion, due both to a reduction in large zooplankton body size and a reduction in microzooplankton abundance. These effects can be attributed to reduction of available food (phytoplankton), and direct predation on microzooplankton.*
- *Experimental evidence exists that zebra mussels can reduce the growth rate of larval fish through food web interactions (Raikow 2004).*
- *While dreissenids now appear to be a contributing food source to whitefish diet, this shift appears to be less energetically profitable to whitefish, whose growth rate has declined following dreissenid invasion despite sustained levels of consumption (Pothoven and Madenjian 2008).*
- *Declines in* Diporeia *spp., another benthic invertebrate, have been highly correlated with dreissenid expansion (Fahnenstiel et al. 2010, Nalepa et al. 2006, Watkins et al. 2007).* Diporeia *is an important prey item linking the benthos to higher trophic levels, and it has been suggested that the shift from* Diporeia *to* Dreissena *has transformed the benthic community into an energy sink which may no longer support the upper food web (Nalepa et al. 2009).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6 √
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

- *Diatom abundance declined 82-91%, and transparency as measured by Secchi depth increased by 100% during the first years of the invasion in Lake Erie (Holland 1993).*
- *In Lake Huron's Saginaw Bay, sampling stations with high zebra mussel populations experienced a 60-70% drop in chlorophyll* a *and doubling of Secchi depth (Fahnenstiel et al. 1993). Phytoplankton biomass declined 85% following mussel invasion in the Hudson River (Caraco et al. 1997).*
- Microcystis *became a prevalent alga in Saginaw Bay, Lake Huron following the invasion of zebra mussels. The introduction appeared to spur a number of other changes to the phytoplankton community as well, including a shift from shade-tolerant species to light-tolerant species (Fishman et al. 2010). This study, along with others, indicates that zebra mussels can have a significant effect on nutrient cycling in invaded ecosystems.*
- *Zebra mussels can direct phosphorous and other nutrients to those nearshore areas inhabited by mussels and retain them there, while offshore regions suffer from declining nutrient levels and often become mesotrophic or oligotrophic (Hecky et al. 2004).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6 √
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

- *In Lake Erie, the rate of biosedimentation through pseudofeces production was very high (28mg/cm^2 day at a density of 1180 individuals/m^2) under turbid conditions, lending support to the hypothesis that zebra mussels are responsible for increased water clarity observed since mussel introduction (Klerks et al. 1996).*
- *Increased water clarity allows light to penetrate further, potentially promoting macrophyte populations (Scheffer et al. 1993, Skubinna et al. 1995).*
- *Increasing amounts of pseudofeces and biodeposits could also have an impact on multiple trophic levels via changes to the physical environment. A current study in Brocton Shoal, Lake Erie, suggests that colonization of lakebed areas by dreissenid mussels and the consequent filling of remaining interstitial spaces with pseudofeces and fine-grained sediments may significantly eliminate valuable habitat native habitat (S. Mackey, pers. comm.). Brocton Shoal, once thought to be an important area for lake trout spawning, appears to have diminished suitability as a spawning ground, potentially due to such impacts (S. Mackey, pers. comm.).*

Environmental Impacts Total	**30**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	**<u>High</u>**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

<u>SOCIO-ECONOMIC IMPACT</u>

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6 √
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

- *Zebra mussels are notorious for their biofouling capabilities—colonization of water supply pipes of hydroelectric and nuclear power plants, public water supply plants, and industrial facilities. When inhabiting pipes, they tend to constrict water flow, thereby reducing the intake in heat exchangers, condensers, fire-fighting equipment, and air conditioning and cooling systems.*
- *Zebra mussel densities have been as high as 700,000/m^2 at one power plant in Michigan and have reduced pipe diameters by as much as two-thirds at some water treatment facilities (Griffiths et al. 1991).*

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *The reemergence of nuisance algal species* Cladophora *in Lake Ontario, Lake Erie, and Lake Michigan following the establishment of zebra mussels has been largely attributed to the resulting changes in nutrient cycling and water clarity (Auer et al. 2010, Hecky et al. 2004). Residents and business owners on Lake Ontario have attributed decreases in revenue or property values to these excessive blooms following zebra mussel invasion (Limburg et al. 2010).*

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6 √
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

- *Direct economic costs have resulted from the invasion of zebra mussels in the form of maintenance and repair of power plants, industrial facilities, and other businesses, as well as research, monitoring, and control. A wide variety of estimations have been made regarding zebra mussel-related expenses, ranging from $92,000 per hydroelectric plant per year to $6.5 billion in total costs over 10 years (Lovell et al. 2006).*
- *Reductions in zooplankton biomass may cause increased competition, decreased survival, and decreased biomass of planktivorous fish, including commercially important species.*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6 √
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U

- *Navigational and recreational boating can be affected by increased drag from attached mussels. Small mussels can get into engine cooling systems causing overheating and damage. Navigational buoys have been sunk under the weight of attached zebra mussels. Fishing gear can be fouled if left in the water for long periods. Deterioration of dock pilings has increased when they are encrusted with zebra mussels.*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6 √
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U

- *Residents and business owners on Lake Ontario have attributed decreases in revenue or property values to excessive blooms of* Cladophora *following zebra mussel invasion (Limburg et al. 2010).*

Socio-Economic Impact Total	**25**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	

0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

- *Zebra mussels have also been used in biomonitoring of contaminants (Mackie et al. 1989).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1 √
Not significantly	0
Unknown	U

- *Zebra mussels removed metals from the water column of Lake Erie and deposited it to the bottom at high rates (Klerks et al. 1996).*
- *Increased water clarity following zebra mussel introduction is perceived as a benefit by some, especially business owners and residents on invaded water bodies (Limburg et al. 2010)*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

- *Experimental studies have shown that zebra mussels generally increase benthic macroinvertebrate densities, sometimes by more than 10-fold (Botts et al. 1996, Ricciardi et al. 1997, Ward and Ricciardi 2007). Some benthic fishes may benefit from the increased food resource.*
- *Several species of native fish may prey on zebra mussels in varying degrees, including lake whitefish (Madenjian et al. 2010, Rennie et al. 2009), freshwater drum, pumpkinseed, yellow perch, and rock bass among others (Watzin et al. 2008).*

Beneficial Effect Total	**1**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Elimia virginica*

Common Name: Piedmont elimia

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- Elimia virginica *is a known host of trematode parasites, including* Philophthalmus megalurus *and* Sphaeridiotrema globulus *(Huffman and Fried 1983, Smith 1980). In one New Jersey Lake, multiple mute swan (*Cygnus olor*) deaths appeared to be caused by* S. globulus *hosted in* E. virginica *at an infection rate of roughly 50% (Huffman and Fried 1983).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual	1 √

level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U

- *During glaciation, the Alleghenian Divide geographically isolated congeners* E. virginica *and* E. livescens*—the former was only found in Atlantic Slope drainages, while the latter was only found in Interior basin drainages (Bianchi et al. 1994). There is recent evidence for hybridization and introgression between the species, whose populations were brought into contact with the opening of the Erie Canal (Bianchi et al. 1994). Hybridization and introgression have the potential to jeopardize the genetic integrity of a species, especially when the population is already small.*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Environmental Impact Total	**1**
Total Unknowns (U)	**5**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6

Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Gillia altilis*

Common Name: Buffalo pebblesnail

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0√
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U√

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √

Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**4**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1

Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring

Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Lasmigona subviridis*

Common Name: Green floater

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0√
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0√
Unknown	U

- *Given the limited distribution of* L. subviridis*, lack of evidence of spread, high densities, or remarkable ecological behaviors, as well as its threatened status in its own native region, it appears unlikely that* L. subviridis *is capable of having a significant impact via competition.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0√
Unknown	U

- *Given the limited distribution of* L. subviridis*, lack of evidence of spread, high densities, or remarkable ecological behaviors, as well as its threatened status in its own native region, it appears unlikely that* L. subviridis *is capable of having a significant impact via food web effects.*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline	6

or extinction of one or more native species	
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6

Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

<u>BENEFICIAL EFFECT</u>

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Pisidium amnicum*

Common Name: Greater European peaclam

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0√
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0

Unknown	U√

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Environmental Impact Total	**0**
Total Unknowns (U)	**5**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1

Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring

Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Pisidium henslowanum*

Common Name: Henslow peaclam

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

- *Recent sampling in Lake Superior indicates that* P. henslowanum *has a greater abundance in the Duluth-Superior Harbor area than any species of native peaclam (*Pisidium *spp.), suggesting that* P. henslowanum *may possess some invasive trait(s) or compete with native species (Mackie 2000b, Trebitz et al. 2010).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level	1

AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**5**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6

Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

<u>BENEFICIAL EFFECT</u>

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √

Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Pisidium moitessierianum*

Common Name: Pygmy peaclam

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0√
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U√

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0

Unknown	U√

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Environmental Impact Total	**0**
Total Unknowns (U)	**5**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1

Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring

Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Pisidium supinum*

Common Name: Humpbacked peaclam

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0

Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**5**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1

Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Potamopyrgus antipodarum*

Common Name: New Zealand mudsnail

Environmental: Moderate
Socio-Economic: Unknown
Beneficial: Low

Comments:
Most impacts thus far have been documented in the Western U.S.; across studies, results are often conflicting.

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- Potamopyrgus antipodarum *is capable of serving as a host for a number of trematode parasites, although the extent of occurrence and consequences in its nonindigenous range is largely unknown (see Morley 2008).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

- *Abundant populations of introduced* P. antipodarum *may outcompete other grazers for food resources and inhibit colonization by other macroinvertebrates and native snails (Kerans et al. 2005).*
- *In one Australian stream, increasing densities of* P. antipodarum *were positively correlated with density and species richness of native invertebrates, possibly due to coprophagy (ingestion of the snail's feces) (Schreiber et al. 2002). However, in Europe,* P. antipodarum *has caused declines in species richness and abundance of native snails in constructed ponds (Strzelec 2005).*
- *A colonization experiment in Yellowstone National Park found a negative relationship between the abundance of* P. antipodarum *colonizers and native macroinvertebrate colonizers on stone tiles placed in several rivers, suggesting that* P. antipodarum *may interfere with the colonization activity of native species (Kerans et al. 2005). However, across sites, Kerans et al. (2005) did not find significant negative correlations between the densities of* P. antipodarum *and native macroinvertebrate densities, and overall impacts in this area remain largely unknown.*
- *Stable isotope analysis indicated that the diet of* P. antipodarum *overlaps with the diets of coexisting native invertebrates in the Columbia River Estuary; however, the authors also found that* P. antipodarum *foraging was decreased in the presence of native* Gnorimosphaeroma insulare*, while foraging of* G. insulare *was unaffected by interspecific competition (Brenneis et al. 2010).*
- *Cross et al. (2010) did not detect any impact on native species biomass following the invasion of* P.

antiodarum *in Glen Canyon of the Colorado River. In contrast, field surveys below the Flaming Gorge Dam, documented an overall decrease in total invertebrate abundance following* P. antipodarum *invasion (Vinson et al. 2007). Interestingly, some invertebrate groups that were not affected by* P. antipodarum *overall were reduced in the presence* of P. antipodarum *in certain habitats (e.g., amphipods in eddies and mayflies in runs/riffles) (Vinson et al. 2007).*

- *In an enclosure competition experiment in Branbury Springs, ID, Richards (2004) found that resource-related competitive interactions likely have adverse effects on growth rates of a threatened native snail,* Taylorconcha serpenticola*, at* P. antipodarum *densities above 4,000 m^{-2}. Riley et al. (2008) also found that* P. antipodarum *was a superior competitor to a native snail* Pyrgulopsis robusta *in Yellowstone National Park, documenting a negative correlation between their growth rates. Interestingly, analysis indicated that both species consumed similar amounts of algal resources, discrediting resource acquisition ability as a mechanism for interspecific competition. The authors suggest that adverse impacts on* P. robusta *could stem from lower maintenance costs or more efficient resource conversion within* P. antipodarum *(Riley et al. 2008).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

- *While* P. antipodarum *has been documented as a food source for recreationally valuable salmonids (Bersine et al. 2008, Vinson et al. 2007), its lack of digestibility could be detrimental to its predators (Vinson and Baker 2008).Vinson and Baker (2008) found that 53.8% of New Zealand mudsnails passed through the digestive system of rainbow trout alive, with only 8.5% of snails estimated to have been fully digested. Furthermore, rainbow trout that were fed on a diet of* P. antipodarum *lost 0.14-0.48% of their initial weight per day.*
- *Unsuitability of* P. antipodarum *as a food source and its potential competitive effects within lower trophic levels may affect food availability and alter food web processes in invaded systems (Kerans et al. 2005).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects	1 √

have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U

- *In geothermal streams of the western U.S.,* P. antipodarum *can reach densities of 300,000 snails/m^2 and has been shown to alter nutrient (nitrogen and carbon) flows, consume a large portion of daily gross primary production (GPP), and account for most of the invertebrate production (Hall et al. 2003, Hall et al. 2006).* Potamopyrgus antipodarum *also appeared to play a large role in nitrogen cycling through extensive ammonium excretion (Hall et al. 2006).*
- *A study by Arango et al. (2009) suggested that by selectively grazing on non-nitrogen-fixing components of the algal assembly,* P. antipodarum *was able to increase nitrogen fixation in a high-productivity stream.*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *In geothermal streams of the western U.S.,* P. antipodarum *can reach densities of 300,000 snails/m^2 and consume a large portion of daily gross primary production (GPP) and account for most of the invertebrate production (Hall et al. 2003, Hall et al. 2006).* P. antipodarum *also appeared to play a large role in nitrogen cycling through extensive ammonium excretion (Hall et al. 2006).*
- *A study by Arango et al. (2009) found that* P. antipodarum *altered periphyton community composition over a short time period by selective feeding in the high-productivity stream.*

Environmental Impact Total	**2**
Total Unknowns (U)	**3**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1√
Not significantly	0
Unknown	U

- *Densities have reached 500,000 individuals per square meter in a Snake River tributary of Idaho (Richards et al. 2001); a species this prolific has potential to be a biofouler at facilities drawing from infested waters. Historically*, P. antipodarum *has both blocked and been distributed through water pipes in Australia (Ponder 1988).*

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U √

- *If* P. antipodarum *has adverse impacts on food web interactions in invaded ecosystems (see above), it is possible that certain recreationally or commercially valuable species such as rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) could be negatively impacted at high snail densities (Proctor et al. 2007).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**1**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √

Not significantly	0
Unknown	U

- *Partially due to their relatively high tolerance of environmental stressors,* P. antipodarum *is often used as a research organism to test novel experimental/analytical techniques (e.g., Myrick 2009, Schmitt et al. 2010a) or to test the physiological effects of toxic chemicals an aquatic fauna—particularly effects on the endocrine system (e.g., Alonso and Camargo 2009, Gust et al. 2009, Schmitt et al. 2010b)*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**1**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Radix auricularia*

Common Name: European ear snail

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- *In Europe and Asia,* R. auricularia *is a host to such parasites as* Echinoparyphium recurvatum *(Sohn et al. 2002),* Trichobilharzia franki *(Ferte et al. 2005),* T. ocellata *(Zbikowska 2004),* T. szidati *(Kolarova et al. 1997),* Clinostomum complanatum *(Chung et al. 1998),* Mantoscyphidia radixi *(Boshko 1993), and* Orientobilharzia turkestanica *(Tang et al. 1990), some of which may also infect birds, mammals, and amphibians (Soldánová et al. 2010).*
- *In one German survey, 20% of captured* R. auricularia *were infected with trematode parasites (Soldánová et al. 2010).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Environmental Impact Total	**1**
Total Unknowns (U)	**4**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

- Radix auricularia *is a documented host of a number of parasites that cause dermatitis known as "swimmer's itch," including* Orientobilharzia turkestanica *(Majoros et al. 2010, Tang et al. 1990),* Trichobilharzia franki *(Ferte et al. 2005), and* T. ocellata *(Zbikowska 2004). Cases related to* R. auricularia *have been documented in Europe (Zbikowska 2004).*

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**1**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority	1

OR It is potentially important to medicine or research and is currently being or scheduled to be studied	
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Sphaerium corneum*

Common Name: European fingernail clam

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- *In North America,* Sphaerium corneum *hosts such digenean species* as Crepidostomum transmarinum, Bunodera lucipercae*, and* Phyllodistomum simile*, which also parasitize fish, including salmonids. These species have been recorded from the Ottawa River, which flows into the St. Lawrence River in Canada (Mackie 1976, Mackie 2000b).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual	1

level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Environmental Impact Total	**0**
Total Unknowns (U)	**5**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

- Sphaerium corneum *shells have reportedly caused blockages in one water supply plant in Britain, although this type of problem has not been reported frequently (Clarke 1987).*

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**1**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

- Sphaerium corneum *has been used frequently to conduct research on accumulation rates and metabolism of toxic chemicals and contaminants (e.g., Borchert et al. 1997, Penttinen et al. 1996, Verrengia Guerrero et al. 2002).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

- *In Lake Ontario and Cayuga Lake (part of the Lake Ontario drainage in New York state),* S. corneum *has been recorded as a host to the oligochaete* Chaetogaster limnaei limnaei*. This oligochaete is probably quite widespread in North America, where it is typically a commensal of native snails, some other native* Sphaerium *spp., and at least one native limpet species (Barbour 1977).*

Beneficial Effect Total	**1**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Valvata piscinalis*

Common Name: European stream valvata

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

- Valvata piscinalis *could act as a vector of parasites, including the parasitic trematode flukes* Echinoparyphium recurvatum *and* E. mordwilokoi, *which it has hosted in its native range (Evans et al. 1981, Grabda-Kazubska and Kiseliene 1991, McCarthy 1990).*

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

- *This species has the potential to compete with native gastropods for food and space (Grigorovich et al. 2005). Unlike native gastropods, it is capable of filter feeding on suspended food items in eutrophic conditions, which could conceivably allow it to become competitively dominant in such conditions (Grigorovich et al. 2005).*
- *When* V. piscinalis *was introduced to Oneida Lake, native gastropods (in particular, hydrobiid snails) appeared to decrease in abundance (Grigorovich et al. 2005), possibly due to competition.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**5**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the	6

natural or cultural character of the area, or significantly reduced the area's value for future generations	
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √

Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Viviparus georgianus*

Common Name: Banded mystery snail

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it outcompete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

- *The banded mystery snail may prey on fish embryos.* Viviparus georgianus *has been shown to significantly reduce survival of largemouth bass eggs in guarded nests both in the laboratory and in ponds, and may contribute to high incubation mortality seen in natural field settings (Eckblad and Shealy 1972).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes that may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level	1

AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	**0**
Total Unknowns (U)	**4**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6

Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √

Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species that is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

- *Anecdotal evidence suggests that mallard ducks are adapting to foraging on this species in Lake George, New York.*

Beneficial Effect Total	**0**
Total Unknowns (U)	**0**

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

A.8 Plants

Scientific Name: *Agrostis gigantea*

Common Name: Retop

Environmental: Unknown
Socio-Economic: Low
Beneficial: Unknown

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0√
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U√

Agrostis gigantea *exhibits aggressive reproductive characters and is reportedly very competitive with native species (CNPS 2002). It should not be introduced if native revegetation is sought (Tilley et al. 2010).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Redtop provides a new food source for some grazers. However, Dugger et al. (2004) found that rabbit density was lower in redtop-dominated habitat relative to natural areas with taller and denser vegetation, probably due to relatively reduced cover and food availability in redtop areas. Additionally, one foraging study of introduced Rocky

*Mountain elk (*Cervus elaphsu nelsoni*) in the French River region (Ontario) suggested that* A. gigantea *is not a significant forage species for elk populations in the Great Lakes region (Jost et al. 1999).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Environmental Impact Total	**0**
Total Unknowns (U)	**4**

Scoring		
Score	# U's	**Impact**
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**

1	≥1	

Scientific Name: *Alnus glutinosa*

Common Name: Black alder, European alder

Environmental: Moderate
Socio-Economic: Low
Beneficial: Unknown

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0√
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

Black alder is an ornamental species, but may be discouraged for use in natural areas due to its reported ability to form monocultures (Eckel 2003, NatureServe 2010).
With the potential to dominate wetland communities, the Ontario Invasive Plants Working Group has labeled A. glutinosa as a top priority for management (Havinga 2000).

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0√
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the	6

decline or extinction of one or more native species	
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Alnus glutinosa *hybridizes readily with many other alders; three of these species are native to the US (Funk 1990, USDANRCS n.d.). Two of the species,*Alnus rhombifolia Nutt. and Alnus rubra Bong. *are native to the west coast. A portion of the native range for* Alnus serrulate (AIton) Willd. *is in the Great Lakes; it can be found in Illinois, Indiana, Ohio, Pennsylvania, and New York (USDANRCS n.d.).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Black alder leaf litter easily leaches nitrogen and water-soluble organic substances (Funk 1990).
Black alder could further impact water courses by de-oxygenating the water, shading out other species, and degrading habitat. Black alder's dense root system is capable of trapping sediment and subsequently altering water flow in wetland ecosystems (Funk 1990).

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Alnus glutinosa *is associated with number of nitrogen-fixing actinomycetes fungi that directly increase soil nitrogen concentrations (Hall et al. 1979). Its leaves are also nitrogen-rich and have been shown to significantly increase nitrogen concentrations via leaf litter leaching (Mikola 1958).*
Black alder is a pioneer species capable of modifying the environment by colonizing exposed soils, fixing nitrogen, and producing copious amounts of litter (Funk 1990, USDANRCS 2006).
Results from a study conducted by Vogel et al. (1997) suggest that as atmospheric carbon dioxide concentration increases, nitrogen fixing species (such as black alder) will be able to fix more atmospheric nitrogen. This will lead to an increase in nitrogen concentration (above current fixation rates) in leaves and, ultimately, in soils via leaf litter decomposition (Vogel et al. 1997).
Areas planted with black alder at a mine restoration site in Kentucky had twice as much leaf litter and higher concentrations of soluble salts than areas without black alder; this leaf litter also resulted in significantly more acidic spring soil (Plass 1977).

Environmental Impact Total	3
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

<u>SOCIO-ECONOMIC IMPACT</u>

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

While black alder does have small scale environmental impacts on water quality (see Environment Impact section), these impacts are not significant to recreational, commercial or other human uses of water.

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1

Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0
Unknown	U√

While it is not considered a commercially-valuable hardwood, Alnus glutinosa *is kept by some US nurseries to meet the demand for use in orchards (as a windbreak) and at mine revegetation sites (Mikola 1958, USDA NRCS 2006). The wood may be used for carving and the leaves for medicinal purposes (Mills et al. 1993).*

Black alder acts as a significant source of nitrogen, which typically becomes available for other species and has been shown to increase growth in nearby trees (Funk 1990, Mikola 1958, Plass 1977). For this reason, black alder is sometimes recommended as a nurse crop (a species interplanted with the species of interest in order to assist in its growth) for numerous hardwood tree species (Bohanek and Groninger 2005, Plass 1977, Shepperd and Jones 1985, Vogel 1981).
*When interplanted on coal mine reclamation sites, black alder's presence was associated with the doubling in size of adjacent yellow-poplar (*Liriodendron tulipifera*), white ash* (Fraxinus americana*), and American sycamore* (Plantanus occidentalis) *(Vogel 1981). In a seven year study of shale mining reclamation sites in Estonia, black alder stands showed high survival and productivity rates, as well as reduced soil pH and phosphrous concentration (Kuznetsova et al. 2011).*
Potential for commercial benefits exists; the extent of applicability to the Great Lakes region is unknown.

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

The wood may be used for carving and the leaves for medicinal purposes (Mills et al. 1993).

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1√
Not significantly	0
Unknown	U

In a supercritical carbon dioxide extraction of A. glutinosa, *β-sitosterol and eleven pentacyclic triterpenes were identified (Felföldi-Gáva et al. 2012). These compounds have a variety of potential pharmacological applications, including stunting cancer tumor growth and protecting against the side effects of chemotherapy and radiation treatment (Laszvzyk 2009, MDidea 2010). This group of compounds has also been found to have anti-inflammatory, antioxidant, antimicrobial, and antiviral properties, as well as cardiovascular benefits (MDidea 2010, Patočka 2003). One identified compound, betulinic acid, has been demonstrated to have antiviral properties against HIV (DeClercq 2000).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

Due to its ability to colonize acidic soils and provide a source of nitrogen, black alder can aid in the restoration of disturbed sites and spoil banks (Funk 1990).
In an evaluation of the soil remediation ability of trees, Chodak and Niklińska (2010) found that A. glutinosa *caused the largest accumulation of organic carbon and total nitrogen of all examined tree species, but was also associated with the most acidic soils.*
Black alder may provide food for deer, rabbits, hares, and several bird species. Black alder seeds are released from cones throughout the winter, potentially benefiting seed-eating birds (Funk 1990).

Beneficial Effect Total	1
Total Unknowns (U)	2

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Alopecurus geniculatus L.*

Common Name: Water foxtail, marsh foxtail, floating foxtail

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0√
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U√

In areas outside of the Great Lakes, Kalusová et al. (2009) found that A. geniculatus *abundance increased with increasing soil phosphorus levels and speculated that it could be a competitive grass species in nutrient-rich soils. However, Peeters (2004) classified A. geniculatus as a generally poor competitor.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6

Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Although it is capable of hybridizing with the native shortawn foxtail (Alopecurus aequalis), *only sterile offspring are produced (Klein 2011).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U√

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

It may dominate wet microsites, and if infestations reach sufficiently high densities, it could alter community structure (layers) in invaded wet areas (Klein 2011, Peeters 2004).
It is typically found in wet, nutrient-rich soils and is described as moderately to very demanding of soil nutrients (Peeters 2004). This suggests that A. geniculatus *could influence nutrient availability or soil chemistry (Klein 2011, Peeters 2004).*

Environmental Impact Total	1
Total Unknowns (U)	3

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6

Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Butomus umbellatus*

Common Name: Flowering rush

Environmental: Moderate
Socio-Economic: Unknown
Beneficial: Unknown

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0√
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

Butomus umbellatus *forms dense stands in southern Lake Champlain, where it appears to displace native species (Marsden and Hauser 2009).*
Butomus umbellatus *can displace native riparian vegetation via competition and could diminish native biodiversity as a result (MPLP 2006).*
At about 40% of the sites at which it was found on the St. Lawrence River, B. umbellatus *made up more than 50% of the total species cover, suggesting that it is capable of dominating wetland sites (Lavoie et al. 2003). However, Shannon diversity indices and number of native plant species were still greater at sampling stations with* B. umbellatus *than at stations with the harmful exotic grasses* Phalaris arundinacea *and* Phragmites australis *(Lavoie et al. 2003). Lavoie et al. (2003) speculated that even the densest populations of flowering rush may leave some available space for native species as a result of its particular growth form.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0

Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

It is capable of forming dense mats which could affect the availability of light, nutrients, and dissolved gasses in colonized waters (MPLP 2006).
Infestations could also result in increased water temperatures and altered nutrient flows and/or sedimentation rates. Flowering rush has resulted the complete obstruction of open water, reduced water flow and increased sedimentation in Montana and southwest Idaho (Rice and Dupuis 2009).

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1√
Not significantly	0
Unknown	U

Infestations could result in increased water temperatures and altered nutrient flows and/or sedimentation rates (Rice and Dupuis 2009).
In the western U.S., emergent monocultures have colonized and reduced areas of open water; although scientific study is limited, these invasions have reportedly reduced water flow in canals and modified the physical structure of previously unvegetated localities (Rice and Dupuis 2009).

Environmental Impact Total	3
Total Unknowns (U)	1

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Concerns have arisen in the western U.S. regarding the role of B. umbellatus *populations as an ideal habitat for the great pond snail* (Lymnaea stagnalis), *an intermediate host of a trematode* (Trichobilharzia ocellata) *responsible for swimmer's itch (Rice and Dupuis 2009).*

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1√
Not significantly	0
Unknown	U

Wild rice (Zizania aquatic) *has been identified as a species potentially threatened by the spread of* B. umbellatus *in the wetlands of the northern United States and Canada (Lui et al. 2005, MPLP 2006). Reduction in wild rice harvests could affect indigenous people who live in the area (B. Ranta pers. comm. to Lui 2001).*
In the Aberdeen-Springfield canal system (ID), B. umbellatus *has colonized an estimated 150 miles of the 300 mile main canal, threatening water availability for potato and cash crops and requiring removal every 2 or 3 years. Full management of flowering rush in this canal system could raise costs to farmer shareholders by as much as 8% (Rice and Dupuis 2009).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Butomus umbellatus *can obstruct irrigation canals and interfere with industrial shoreline uses, boat traffic, and other recreational activities (Eckert et al. 2000, MPLP 2006).*
Flathead Lake (MT) has been infested by monocultures of flowering rush that have inhibited boat passage and reduced open water availability for swimming and fishing (Rice and Dupuis 2009).

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U√

Stands of B. umbellatus *can become thick and undesirable, even in its native range (Hroudová et al. 1996).*

Socio-Economic Impact Total	1
Total Unknowns (U)	2

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

It has been used as an aquatic ornamental plant, though it is now prohibited in several Great Lakes states (GLPANS 2008, Les and Mehrhoff 1999).

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1√
Not significantly	0
Unknown	U

The roots and seeds of B. umbellatus *are edible, and the plant has been investigated for some medicinal uses (e.g., anti-microbial properties were tested but not discovered) (Özbay and Alim 2009).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

Muskrats use parts of the plant for habitat, and ducks reportedly graze on B. umbellatus *in its native range (potentially offering some control of the plant) (Hroudová et al. 1996).*
Flowering rush could provide structural habitat for some fish species, particularly those which depend on vegetation for spawning (Rice and Dupuis 2009).

Beneficial Effect Total	1
Total Unknowns (U)	1

Scoring		
Score	# U's	Impact

>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

Scientific Name: *Cabomba caroliniana* Gray

Common Name: Carolina fanwort

Environmental: Moderate
Socio-Economic: Moderate
Beneficial: Unknown

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

Cabomba caroliniana *is an extremely persistent and competitive plant, growing quickly and crowding out other vegetation (WI DNR 2012, Wilson et al. 2007).*
Populations of C. caroliniana *readily form dense mats that block sunlight penetration to lower water depths and shade out germinating seeds or propagules (ENSR International 2005, Forest Health Staff 2006 Wilson et al. 2007). After an analysis of invasive species by the U.S. Army Corps of Engineers, the predicted expansion of* C. caroliniana *was so extensive that this species could pose a severe threat to ecosystems in Minnesota (Madsen 1999). Warmer winter temperatures and lower water levels may aide in the continued northward expansion of* C. caroliniana *(Hudon and Carignan 2008).*
Cabomba caroliniana *has formed monocultures in Kasshabog Lake, Ontario (Hosgsden et al. 2007 Wilson et al. 2007). The main difference between native macrophyte beds and beds of* C. caroliniana *in this location is significantly reduced light penetration (Hogsden et al. 2007).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1 √
Not significantly	0
Unknown	U

Dense stands of C. caroliniana *disrupts fish habitat and replaces native foods sources; which can alter predator/prey relationships among the fish populations (ENSR International 2005, OISAP 2005, PA DCNR 2011, Program 2013).*
Morrison and Hay (2011) found that in response to direct feeding activity, C. caroliniana *is capable of inducing a chemical defense to suppress herbivory.*
Cabomba caroliniana extracts *also inhibited growth of 5 different microbes by 20-90%, suggesting that* C. caroliniana *has an anti-microbial defense at feeding scar sites (Morrison and Hay 2011).*
Due to its ability to induce a chemical defense, the establishment of C. caroliniana *could have implications for herbivore fitness and trophic interactions, as well as important microbial activities (Morrison and Hay 2011).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Large infestations can affect the oxygen concentrations, pH, and organic content of the nearby water and soil (ENSR International 2005, PADCNR 2011).
Furthermore, dieback and decomposition could alter nutrient cycling, potentially reducing dissolved oxygen levels and increasing manganese levels (Wilson et al. 2007).

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Cabomba caroliniana *mats can trap detritus and increase sedimentation which could alter the hydrology or even clog freshwater streams and drainage canals (ENSR International 2005, Forest Health Staff 2006, U.S. EPA 2008).*

Environmental Impact Total	4

Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Dense mats of C. caroliniana *clog streams, drainage canals, and drinking water intakes and interferes with agricultural water uses (WI DNR 2012).*
Cabomba caroliniana is *capable of significantly reducing water storage capacity and tainting/discoloring drinking water supplies, potentially increasing water treatment costs (Lui et al. 2010).*

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR	1 √

It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U

If C. caroliniana *spreads from Kasshabog Lake to the Trent-Severn Waterway and Great Lakes system, power generation, aquaculture, and other water-based industries could be impacted (Wilson et al. 2007).*
Limitations on water uses can negatively impact real estate values (ENSR International 2005).
An estimated $500,000 a year was spent on control of C. caroliniana *in Australia as of 2003 (ADEH 2003, Schooler et al. 2006).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

Cabomba caroliniana's *dense mass of underwater leaves and stems provide a tangling hazard for swimmers, boats, fishing lines, and other recreational water users (Ensbey and Oosterhout 2010, Schooler et al. 2006, Wilson et al. 2007).*
At Kasshabog Lake, Ontario, C. caroliniana *has become a nuisance for residents and recreational users, discouraging swimming and boating… (Wilson et al. 2007).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

Infestations of this species can cause the water to become stagnant will can cause it to become dark and foul-smelling; ultimately reducing the aesthetic value (Ensbey and Oosterhout 2010).
At Kasshabog Lake, Ontario, C. caroliniana *has reportedly affected the aesthetic value of shoreline property (Wilson et al. 2007).*

Socio-Economic Impact Total	4
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6

Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1 √
Not significantly	0
Unknown	U

Because of its attractive appearance and its ability to grow quickly, C. caroliniana *has been a commercially-important plant in the aquarium trade worldwide (Wilson et al. 2007).*
Rixon et al. (2005) documented its presence in 20% of investigated aquarium stores in the Great Lakes region, while Cohen et al. (2007) reported C. caroliniana *as one of the top 10 plants in the Montreal aquarium trade.*
Additionally, C. caroliniana *was one of the most popular aquatic plants among surveyed aquarium owners in Canada (Marson et al. 2009).*
However, C. caroliniana *is also restricted or prohibited in some Great Lakes states (GLPANS 2008).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Preliminary research indicated that C. caroliniana *plant matter that is mechanically harvested for control purposes could be anaerobically digested to produce and harness methane-rich gas for energy purposes (O'Sullivan et al. 2010).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Cabomba caroliniana *is capable of sequestering lead and may be useful in reclamation efforts (Mikulyuk and Nault 2011).*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6

Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

While the composition of algae and macroinvertebrate communities were similar between native macrophyte and C. caroliniana *beds in Kasshabog Lake, both were more abundant in* C. caroliniana *beds, potentially because its growth morphology provided more favorable structure for habitat (Hogsden et al. 2007).*
Relative to native macrophytes, its ecological value as a source of food or habitat for wildlife is unclear (Wilson et al. 2007).
However, in some instances C. caroliniana *may provide cover for macroinvertbrates and spawning ground for fish (Hamel 2013, Tilt 2013).*

Beneficial Effect Total	1
Total Unknowns (U)	1

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

Scientific Name: *Carex acutiformis*

Common Name: Swamp sedge, lesser pond sedge, European lake sedge

Environmental: Moderate
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

In 1982, C. acutiformis *was observed forming a near monoculture around the entirety of St. Joseph Lake, South Bend, IN.*
Carex acutiformis *was discovered dominating a 6-acre open marsh area in the Stony Swamp Conservation Area near Ottawa, ON, where it co-existed with native trees but had displaced nearly all other native plants in both open water and some relatively dry areas (Catling and Kostiuk 2003).*
This species may be a very serious threat to native vegetation on a local geographic scale due to its ability to spread rapidly via vegetative growth and out-compete native species for nutrients and light (Catling and Kostiuk 2003, A. Reznicek, pers. comm.).

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

As of 1992, a total of 253 Carex *hybrids had been reported in North America. This indicates that this genus is highly capable of hybridization, and invasive species, such as* C. acutiformis, *may be a genetic threat to native sedge species (Cayouette and Catling 1992).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

The decomposition of cellulose in C. acutiformus *plant matter may occur slowly, preventing the full release of nutrients until 3-4 years after death and immobilizing N and P for a longer period of time relative to other sedges (Aerts and de Caluwe 1997, Verhoeven and Arts 1992). However, because* C. acutiformis *produces more leaf litter than most sedges, it may actually facilitate a higher rate of nutrient cycling than what the other sedges attain (Aerts and de Caluwe 1997).*
Carex acutiformis *may smother native plants via accumulation of its excess litter (Catling and Kostiuk 2003).*

Environmental Impact Total	2
Total Unknowns (U)	2

Scoring		
Score	# U's	Impact
>5	Any	High

2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √

Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority	1

OR It is potentially important to medicine or research and is currently being or scheduled to be studied	
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Carex disticha* Huds.

Common Name: Tworank sedge, two-tank sedge, two rank sedge

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0√
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0√
Unknown	U

It was reportedly a dominant plant where it established in Simnoe County, Ontario (Catling et al. 1988).
Carex *spp. can transport oxygen from above ground portions to its deep root system, which enables these species to compete in water-logged ecosystems (Riutta et al. 2007).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0√
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6

Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

As of 1992, a total of 253 Carex *hybrids have been reported in North America. This indicates that this genus is highly capable of hybridization, and invading species, such as* C. disticha, *may be a genetic threat to native species of sedges (Cayouette and Catling 1992).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1

Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0√
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Chenopodium glaucum*

Common Name: Oak-leaved goosefoot

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Chenopodium glaucum *is one of the many members of the* Chenopodium *genus that is reported to produce saponins (Al-Jaber et al. 1992, Larina 2008).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Chenopodium glaucum *could pose a competitive threat to* Chenopodium *spp. that extend into the Great Lakes for at least a part of their native range. These species include (but are not limited to):* C. album, C. berlandieri, C. capitatum, C. foggii, C. humile, C. leptophyllum, C. overi, C. pallescens, C. pratericola, C. rubrum, C. salinum, C. simplex, C. standleyanum, *and* C. subglabrum *(USDA NRCS 2012).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Chenopodium glaucum *is capable of naturally hybridizing with* C. rubrum, *which is native to Ontario, Michigan, Wisconsin, Minnesota, and Illinois (USDA NRCS 2012, Wisskirchen 2006).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	3

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**<u>Unknown</u>**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Plants, such as C. glaucum, *that contain saponinshave been blamed for non-fatal poisonings in livestock, such as poultry and swine. New research indicates that saponins might be beneficial to species with rumen digestion systems (Cornell University 2009).*
This species is described as a widespread weed in Russia, invading crop fields and vegetable gardens (Larina 2008).

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0
Unknown	U √

Chenopodium glaucum *is reported to have some value as forage due to high protein content in the leaves; however, over fertilization and insufficient water can create high, potentially toxic, nitrate concentrations (Brotherson et al. 1980, Duan et al. 2004).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority	1

OR It is potentially important to medicine or research and is currently being or scheduled to be studied	
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Chenopodium glaucum *is able to uptake mercury from contaminated soils. Application of thiosulphate greatly increases the solubility of mercury and increases phytoextraction by C. glaucum (Wang et al. 2011).*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	1

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Cirsium palustre* (L.) Coss. ex Scop.

Common Name: Marsh thistle

Environmental: Moderate
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

There is also some evidence that C. palustre *may be allelopathic, although this possibility has not been thoroughly investigated (Ballegaard and Warncke 1985).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1√
Not significantly	0
Unknown	U

Realized impacts on native species and habitats following establishment have yet to be comprehensively documented or investigated (NatureServe 2011). Concern exists over the rapidly expanding range of C. palustre *in the Great Lakes region (e.g., its southward movement in Michigan (Voss 1996)).* Cirsium palustre *can spread aggressively, resulting in reduced biodiversity and compromised ecological integrity; especially in the wetland ecosystems of Great Lakes islands (Cuthbert et al. 2007, USDA Forest Service 2005b).*
This plant is capable of spreading into open, undisturbed wetlands and forming clumps or impenetrable stands of flowering stalks or carpets of rosettes, potentially displacing native vegetation, altering community structure, and threatening natural diversity (Fraser 2000).
Marsh thistle is able to produce 2,000 viable seeds per plants; only a few plants are needed to have a drastic impact on the seed bank of an area (Fraser 2000, Sheehan 2007).
In British Colombia, C. palustre *has been blamed for the degradation of sedge* (Carex spp.) *meadows (Sheehan 2007). This species could pose a threat to the numerous native sedge communities; especially to rare, threatened, or endangered species (USDA NRCS 2012b.).*
Cirsium palustre *poses a threat to* C. pitcheri (Torr. ex Eaton) Torr. & A. Gray, *which is native to the Great Lakes region and is classified as threatened by the federal government and the province of Ontario (COSSARO 2011, USDA NRCS 2012a.). Native swamp thistle,* C. muticum, *may also be at risk for adverse competitive effects (GLIFWC 2006).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects	6

(e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

In Europe, Cirsium arvense *(a native to the Great Lakes) invades native populations of* C. palustre *and hybridizations between the two species have occurred. Such hybridizations are possible in North America where these species grow in close proximity, but none have been reported in the Great Lakes (Gucker 2009).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	2
Total Unknowns (U)	1

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	**<u>Moderate</u>**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

<u>SOCIO-ECONOMIC IMPACT</u>

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Although it is reportedly not a threat to cultivated agricultural areas, it may reduce forage quality following establishment in damp pastures (OLA and MAFF 2002).

It could form dense clumps in logged cut blocks, competing for moisture and nutrients with tree seedlings planted for reforestation. Tall stems can lead to snow press, permanently damaging tree seedlings (OLA and MAFF 2002).

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or	6

tourism	
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1√
Not significantly	0
Unknown	U

Polyphenolic compounds extracted from C. palustre *exhibit anti-microbial properties (Nazaruk et al. 2008).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Conium maculatum* L.

Common Name: Poison hemlock

Environmental: Moderate
Socio-Economic: Moderate
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

The effects of C. maculatum *on livestock are well-known, but corresponding effects on wildlife are less commonly studied. However, poisoning has been documented in elk, rabbits, rats, and some birds (Forsyth and Frank 1993, López et al. 1999, Vetter 2004).*
Conium maculatum *is capable of hosting several disease-causing agents (e.g.,* Xylella fastidiosa*, celery mosaic virus, carrot thin lead virus, and alfalfa mosaic virus) that could spread to surrounding plants from agricultural fields or vineyards (Howell and Mink 1981, Woodard 2008).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

Conium maculatum *is highly competitive and often grows taller than native species, shading and competing for space and nutrients with grasses and forbs (Pitcher 2004). It can be particularly competitive in soils with high nitrogen concentrations, where it rapidly utilizes nitrogen and outgrows other vegetation early in the growing season (Mamolos and Veresoglou 2000).*
Recent research indicates that C. maculatum *is more tolerant of heavy metal contaminants relative to native species, which may explain its ability to colonize disturbed habitats and displace natives during early successional stages. However, Granberg et al. (2009) also found it capable of inhabiting soils of diverse characteristics, suggesting that it is capable of spreading into natural areas.*
There are no specific cases of Conium maculatum *outcompeting native species in the Great Lakes region; however, given its pervasive competitive nature it is probable that this species affects natives in the Great Lakes.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6

Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Most vertebrates suffer from the toxic effects of this species, while very few invertebrates appear to inhabit C. maculatum *or utilize it as a food source, even after being established in the U.S. for two centuries (Castells and Berenbaum 2008).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	2
Total Unknowns (U)	0

Scoring

Score	# U	Impact
>5	Any	High
2-5	Any	**<u>Moderate</u>**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

<u>SOCIO-ECONOMIC IMPACT</u>

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Poisoning of humans has occurred following ingestion of seeds, leaves, and roots, and as a result of blowing through the plant's hollow stems (e.g., when used as whistles or pea-shooters).
The conium alkaloids found in C. maculatum *are volatile and can cause toxic reactions when inhaled.*
Symptoms can include temporary skin reactions (hyperpigmenation, blisters, or burning sensation); decreased muscle control; gastro-intestinal symptoms; nervous system symptoms; and death from respiratory failure, if exposure is large/prolonged (Centre for Aquatic Plant Management 2004, Mitich 1998, Vetter 2004).
Human deaths have occurred from harvesting and consuming the roots as wild carrots or parsnips, but the frequency of cases in the Great Lakes region is unknown.

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR	1 √

It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U

Animals of agricultural importance are also affected by the toxicity of C. maculatum*, including cows, horses, goats, sheep, swine, and poultry (turkeys, chicken, and quails) (Centre for Aquatic Plant Management 2004, Frank and Reed 1990, López et al. 1999).*
Ingestion of plant matter results in acute toxicity characterized by increased salivation, tremors, ataxia, depression, and respiratory distress, possibly leading to respiratory failure with high or prolonged doses (López et al. 1999, Vetter 2004).
Cows and pigs may also experience temporary blindness after ingestion (Panter et al. 1992).
Animals that suffer from chronic toxicity during critical stages of pregnancy often give birth to young with mild to severe skeletal malformations, including cleft palates, arthrogryposis, scoliosis, and palatoschisis (Keeler and Balls 1978, López et al. 1999, Panter et al. 1992, Vetter 2004).
If the initial poisoning is not lethal, livestock animals can recover if future ingestion of C. maculatum *is avoided (Frank and Reed 1987, López et al. 1999).*
Cattle, pigs, goat, and elk should be kept away because they exhibit a preference to continue eating C. maculatum *even after the initial exposure (López et al. 1999, Panter and Keeler 1989).*
Conium maculatum *can outcompete desirable forage species (OLA and MAFF 2002). In addition to its status as a serious pasture weed in the U.S. and other countries, it is also known to infest cereal and vegetable crop fields, as well as orchards (Mitich 1998).*
Alkaloids may be excreted through the milk of poisoned cattle, which can pose a threat to nursing animals or be a food safety concern if the milk is intended for human consumption (Panter and James 1990, Vetter 2004).
Conium maculatum *is capable of hosting several disease-causing agents (e.g.,* Xylella fastidiosa*, celery mosaic virus, carrot thin lead virus, and alfalfa mosaic virus) that could spread to surrounding plants from agricultural fields or vineyards (Howell and Mink 1981, Woodard 2008).*
The extent of impact on Great Lakes agriculture is unknown.

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	2
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	

0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Coniine (a derivative from C. maculatum*) serves as an effective insecticide against aphids and blowflies (Mohammed 1999).*
Conium maculatum *also contains the alkaloid gamma-coniceine which displays antifeedant properties against* Deroceras reticulatum *(Muller), a field slug (Birkett et al. 2004). This species is native to Western Europe, but has been introduced to Michigan, Ohio, and Ontario (White-McLean 2011).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

Extracts of hemlock have been used medicinally for many years in treating tumors, ulcers and gout (Parsons 1973). However, its medicinal importance is ultimately very limited by the narrow distinction between therapeutic and toxic levels of administration (Vetter 2004).
Coniine hydrobromide, derived from C. maculatum*, is used as an antispasmodic (Penn Veterinary Medicine 2012).*
Ultra-diluted natural Conium *remedies used in India were tested to see if this genus had inhibitory effects on breast cancer. These remedies caused cell cycle delay/arrest and apoptosis of the two breast cancer cell lines tested (Frenkel et al. 2010).*
Mixtures of alkaloid containing water-alcohol extracts from C. maculatum *and salicylic acid inhibit symptoms of inflammation (exudation, pain, fever) to the same extent as conventional non-steroidal anti-inflammatory treatments (Nesterova et al. 2009). Nesterova et al. (2009) believe that these substances could be an alternative treatment for pain caused by various inflammatory conditions.*
Conmaculation, a piperidine alkaloid found in C. maculatum*, exhibited strong antinocicpetive activity in mice; however, doses over 20mg/kg were lethal (Radulović et al. 2012). This compound also does not seem to affect locomotor skills (Arihan et al. 2009).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

Scientific Name: *Echinochloa crus-galli*

Common Name: Barnyard grass

Environmental: Moderate
Socio-Economic: High
Beneficial: Moderate

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

This grass has been reported to accumulate levels of nitrate high enough to be toxic to farm animals (Holm et al. 1977).
Echinochloa crus-galli *has been identified as capable of hosting and transmitting the southern rice black-streaked dwarf virus in south China (Li et al. 2012b).*
Root exudates from E. crus-galli *were found to contain 15 phytotoxic compounds that are thought to be allelochemicals against the growth of other plant species (Xuan et al. 2006). Allelochemicals produced by young shoots inhibit the growth of rice and other plants growing in close proximity (Yamamoto et al. 1999 in Xuan et al. 2006).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Echinochloa *spp. are early successional hydrophytes that quickly colonize disturbed wetlands. However, members of this genus do not persist over time and are replaced by perennials (WIDNR 2012).*
Bhowmik and Reddy (1988) found that the presence of barnyard grass in tomato fields reduced the concentrations of nitrogen, phosphorous and potassium in the leaves of tomato plants.
Echinochloa crus-galli *may pose a competitive threat to native species of* Echinochloa *such as* E. muricata *and* E. walteri, *which is endangered in Pennsylvania (PLANTS Team 2012).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR	1

Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Echinochloa crus-galli *also poses a genetic threat to* E. muricata, *because these two species are able to produce hybrids when growing in the same community (OLA and MAFF 2002).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

In 2008, the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) reported that this species was too common to map (Falck et al. 2009).

Environmental Impact Total	2
Total Unknowns (U)	2

Scoring		
Score	# U	Impact

>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6 √
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

In 1985, Hamill and Thomas found barnyard grass in 58% of the cornfields surveyed in Ontario. Estimated corn yield loses of 38% were reported for cornfields with an average barnyard grass density of 9 plants/m^2 (Bosnić and Swanton 1997).

Echinochloa crus-galli *has been observed to impact at least 36 different crops (e.g., rice, lettuce, cotton, tomato) in at least 61 different countries (Bhowmilk and Reddy 1988, Holm et al. 1991 in Xuan et al. 2006, Keely and Thullen 1991, Xuan et al. 2006).*
The longer E. crus-galli *is allowed to grow with a desired crop species, the greater the reduction in yield (Keely and Thullen 1991). Experiments conducted in Sunderland, Massachusetts showed that barnyard grass growing with tomato crops reduced the marketable fruit weight from 26-84% depending on density (Bhowmilk and Reddy 1988). Barnyard grass has been found in 81% of tested rice seed lots and reduced rice yields by up to 40% in one agricultural study (Kennedy et al. 1983). In China, densities of 25 plants/m^2 reduced rice yield by 50% (Chin 2001).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	6
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1 √
Not significantly	0
Unknown	U

Echinochloa crus-galli *was originally cultivated for forage and sold under the name "wonder grass" (OLA and MAFF 2002). It is typically fed to livestock while still green and is appropriate for ensilage, but not for hay (Duke 1996).*
Echinochloa crus-galli *contains diethyl phthalate and phthalic acid, derivatives of which are used commercially in plasticizers in high-molecular-weight polymers. Unfortunately, these derivatives are toxic to humans, animals, fish, aquatic invertebrates, algae, and other microorganisms (Xuan et al 2006).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

Echinochloa crus-galli *is used in folk remedies for carbuncles, hemorrhage, sores, spleen disorders, cancer, and wounds (Duke 1996).*
Echinochloa crus-galli *contains a lipid transfer protein that inhibits the action of* Phytophthora infestans*, a pathogenic fungus that causes late blight of tomatoes and potatoes. These results suggest the possibility of creating crop plants tolerant to late blight by altering their existing genetic code to include this lipid transfer protein (Rogozhin et al. 2009).*
Barnyard grass also has two novel defensins that inhibit several phytopathogenic fungi (Odintsova et al. 2008).

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Echinochloa crus-galli *is capable of leaching excess salts from soils and has been used for soil reclamation in Egypt (Abogadallah and Quick 2009, Aslam et al. 1987). It is also able to remove cadmium, copper, and lead from the soil; this ability is enhanced when citric acid is added to the soil (Kim and Lee 2010). Barnyard grass is also capable of accumulating zinc from wastewater (Liu et al. 2007). Germination of* E. crus-galli *was unaffected when exposed to the waste from a coke plant, a pulp mill, and a waste water treatment facility. Barnyard grass seedling growth increased after exposed to the some of the pollutants from a wastewater treatment plant (Adamus et al. 2001). The ability to withstand unknown pollutants, even thrive under some conditions, indicated the potential to use* E. crus-galli *in constructed wetlands for wastewater treatment.*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1 √
Not significantly	0
Unknown	U

Seeds of barnyard grass can be eaten by songbirds and waterfowl; plants offer cover for waterfowl.

Beneficial Effect Total	3
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

Scientific Name: *Epilobium hirsutum* L.

Common Name: Great hairy willow herb

Environmental: Moderate
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

Shamsi and Whitehead (1977) determined that this species can germinate and grow under conditions of low temperatures and short days; furthermore, due to its growth form and pattern of vegetative reproduction, it can rapidly exploit available space.
The persistent nature of hairy willow herb enables it to form monospecific populations that exclude other, especially native, species (Shamsi and Whitehead 1974) .
A joint survey conducted by the Invasive Plant Associate of Wisconsin (IPAW) and the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) found that Epilobium hirsutum *is a moderate competitor and has a moderate to high impact (Reinartz 2003).*
Epilobium hirsutum *could be a competitive threat to native species in Ohio, including* E. angustifolium *(state endangered) and* E. strictum *(state threatened) (ODNR 2012).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0

Unknown	U √

In Washington state, hairy willow herb disrupts wetland food chains (State of Washington 2012).

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

A few occurrences of hybridization between E. hirsutum *and* E. ciliatum*, a native to the Great Lakes and other parts of North America*, have been found in Europe*, resulting in* E. x novae-civitatis *(Online Atlas 2012). No such hybridization has been reported in the Great Lakes.*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Dense stands of E. hirsutum *impede hydrology in waterways and wetlands (King County 2008, State of Washington 2012).*

Environmental Impact Total	2
Total Unknowns (U)	1

Scoring		
Score	# U’s	Impact
>5	Any	High
2-5	Any	<u>**Moderate**</u>

0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Epilobium hirsutum *can co-exist with* Lythrum salicaria *(purple loosestrife) along riparian areas created by erosion. Great hairy willow herb outcompetes and grows faster than purple loosestrife in the shorter days and colder temperatures of autumn. In the spring, this relationship is reversed, with purple loosestrife having a faster growth rate (Shamsi and Whitehead 1974, Shamsi and Whitehead 1977).*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

Epilobium hirsutum *L. is considered a medical plant in Bulgaria (Ivancheva et al. 1992).*
Ethanolic extracts of E. hirsutum *have antimicrobial properties (Battinelli et al. 2001).*
Methanolic extracts of E. hirsutum *exhibited antinociceptive activity in mice. Doses of 500 mg/kg resulted in higher pain tolerance than doses of diclofenac (50 mg/kg) and morphine (5 mg/kg). Furthermore, doses of the methanolic extract (200-500 mg/kg) did not impair locomotor skills of mice (Pourmorad et al. 2007).*
A polyphenolic mixture of E. hirsutum *(combined with a water-alcohol extract) had a significant inhibitory effect on the reproduction of influenza viruses (Ivancheva et al. 1992).*
A few of the polyphenols extracted from E. hirsutum*, galloylglucose and monomeric and dimeric ellagitannins, are important compounds for the treatment of prostate cancer (Cristea et al. 2009).*
Initial experiments of alcohol extracts from E. hirsutum *indicate other anti-tumor properties. Small doses of alcohol extract (1-3 mg/kg) prolonged the lifespan of mice with tumors by over 150% (Voynova et al. 1991).*
Flavonoids (3-O-glycosides of quercetin, myricetin, and kaempferol) and a macrocircular dimeric ellagitannin oenothein D have been detected in dried fragments of E. hirsutum *(Strgulc Krajšek et al. 2011). Increased intake of total flavonols is associated with a reduced risk of pancreatic cancer, with kaempferol linked to greatest reduction in risk (Nöthlings et al. 2007). In epidemiological studies quercetin supplements reduced blood pressure in hypertensive rodents. Quercetin is thought to be linked with a lowering the risk of coronary heart disease and/or stroke (Edwards et al. 2007).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown

1	≥1	

Scientific Name: *Rhamnus frangula (Frangula alnus)*

Common Name: Glossy buckthorn

Environmental: High
Socio-Economic: Low
Beneficial: Moderate

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

European starlings, rose-breasted grosbeaks, cedar waxwings, and American robins, all of which have at least part of their range in the Great Lakes, feed on the fruits of glossy buckthorn (Michigan Natural Features Inventory 2012). Small mammals, such as rodents, also feed on this berries (NRCS 2007). However, consuming these berries often leads to a net energy loss due to their diarrheic qualities (Czarapata 1999 in Falck and Garske 2002). Rhamnus *spp. are a winter host to the introduced pest soybean aphid,* Aphis glycines *(NRCS 2007). Soybean aphids have been collected from* R. frangula *in Springfield fen, Indiana (Hill et al. 2010).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6 √
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U

In Gavin Bog, Illinois, R. frangula *has displaced* Ilex verticillata*, a native species to the Great Lakes (Taft and Solecki 1990 in Frappier et al. 2003).*
Rhamnus frangula *leafs out early in spring and retains its leaves late into the fall (Ohio EPA 2001, PADCNR n.d.) The leaves remain photosynthetically active until the senesce from the plant, allowing glossy buckthorn to out-compete native trees, shrubs, and wildflowers for light (GLC 2006, NRCS 2007, State of Minnesota 2009).*
The extensive root system of R. frangula *allows it to out-compete native plant for nutrients and water (Ohio EPA 2001, State of Minnesota 2009).*
Rhamnus frangula *may be a competitive threat to two endangered* Rhamnus *spp. in the Great Lakes:* R. alnifolia *(endangered in Illinois) and* R. lanceolata *(endangered in Pennsylvania) (PLANTS Team 2012).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species	1

population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6 √
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

Glossy buckthorn is threatening the current ground vegetation and preventing oak seedling growth in oak savannas, which is an endangered ecosystem in the Midwest (Mills 1993 in Pleasant Valley Conservancy 2012; Reid and Holland 1997).
In Indiana, glossy buckthorn has been recorded invading the understory and reducing the diversity of native plants crucial to native wildlife (Illinois Natural Heritage Database 2011).
Rhamnus frangula *is invading various wetland ecosystems in Wisconsin and is shading out native plants in the process (Thompson and Luthin 2004).*
Sinclair and Catling (1999 in Frappier et al. 2004) found that the presence of R. frangula *in wetlands in Ontario reduced species richness and that when removed, the density of native plants increased.*

Possessky et al. (2000 in Frappier et al. 2004) found that in savanna ecosystems in Pennsylvania the species richness was higher in areas were R. frangula was present.
Mills et al. (2009) also found little change in the resident plant community after glossy buckthorn was allowed to grow and expand freely into the study site.
Monocultures are formed, which harms songbird habitat and shifts the plant ecosystem to those that are more shade tolerant (NRCS 2007, Roman 2007).
Along with changing the amount of available light in an ecosystem, glossy buckthorn also uses allelopathy to alter the plant community around it (PADCNR n.d.).
If glossy buckthorn becomes a dominating species in an ecosystem, the ability of a forest to regenerate and continue through the steps of succession may become severely limited (Forest Health Staff 2006).
Dense patches of glossy buckthorn may also contribute to erosion by shading out other plants that grow on the forest floor (State of Minnesota 2009).
Buckthorns are often found in soils with higher nitrogen content, although it is unknown if this is due to initial establishment conditions or if buckthorns alter the surrounding soil chemistry via their leaf litter. This also makes the surrounding soil environment more favorable for exotic earthworms. Exotic earthworms are known to alter soil characteristics by increasing carbon, nitrogen, pH, and moisture as well as modifying the microbial community (Roman 2007).

Environmental Impact Total	13
Total Unknowns (U)	2

Scoring		
Score	# U's	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Forests of Pinus strobes *that are invaded by* R. frangula *may become less valuable for logging as glossy buckthorn spreads and prevents white pine from regenerating (Fagan and Peart 2004).*
Horses may become poisoned if allowed to consume R. frangula *(van den Dikkenberg and Holtkamp 1987).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Fruits from R. frangula *will stain houses, cars, patio furniture, sidewalks, etc. (State of Minnesota 2009).*

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1 √
Not significantly	0
Unknown	U

In some areas glossy buckthorn is still sold in nurseries in two different forms Columnaris *and* Asplenifolia *(Michigan Natural Features Inventory 2012).*
Glossy buckthorn provides attractive wood that can be used to build trellises, carved into walking sticks, or used in artwork (Larson 2009).

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Many homeowners appreciate dense thickets of R. frangula *forms, because it provides privacy (Larson 2009).*
The wood also burns slowly, making it a good choice for firewood (Larson 2009).

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

Extracts of R. frangula*, often in combination with other plants, have been used in laxatives for humans. Matev et al. (1981) reports that the combination of* R. frangula*,* Citrus aurantium*, and* Carum carvi *was an effective laxative in 100% of the subjects.*
Anthraquinones extracted from R. frangula *successfully inactivated the herpes simplex virus type 1 in laboratory experiments (Sydiskis et al. 1991).*
Methanol extracts of R. frangula *may have anti-fungal properties (Manojlovic et al. 2005).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Rhamnus frangula *is able to accumulate manganese and may be useful is soil remediation (Alvarez et al. 2003).*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

This species provides cover and nesting space for a variety of birds for a longer period of time than native species. However, species nesting in glossy buckthorn can be more susceptible to predation because glossy buckthorn lacks the protective thorns of many native shrubs (Roman 2007).

Beneficial Effect Total	2
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Glyceria maxima*

Common Name: Reed manna grass

Environmental: Moderate
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

Glyceria maxima *invades numerous wetland ecosystems: swamps, lakes, ponds, slow-moving rivers and creeks, ditches, and wet meadows (Boos et al. 2010).*
Early emergence in spring and rapid growth enables this species to outcompete other wetland plants (Buttery and Lambert 1965, King County 2012).
Glyceria maxima *can form monospecifc stands and reduce plant diversity along the shore to a depth of about 15 cm (Andersson 2001, Boos et al. 2010, Forest Health Staff 2006).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1 √
Not significantly	0
Unknown	U

Expansion of G. maxima *degrades the ecological dynamics in the wetland (Forest Health Staff 2006). The displacement of native vegetative often leads to an altered macroinvertebrate community which can impact the entire food web for the ecosystem (King County 2012).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Glyceria maxima *may also be a competitive threat to native species of manna grass. These native species that are listed as threatened or endangered in at least one Great Lake State:* G. acutiflora *Torr.,* G. arkansana *Fernald,* G. borealis *(Nash) Batchelder,* G. grandis *S. Watson, and* G. obtusa *(Muhl.) Trin (PLANTS Team 2012).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Glyceria maxima *have an extensive system of roots and rhizomes (King County 2012). Dense populations of this species create rhizomal mats that can trap sediment faster than native species. This increased sedimentation can alter the flow of water, restrict or even clog small waterway and drainages, and cause flooding (Forest Health Staff 2006, King County 2012).*
Availability of organic material and denitrifying capacity is high in G. maxima *dominant ecosystems (Kallner Bastviken et al. 2007).* Glyceria maxima *also uptakes available ammonium, which further decrease nitrifying activities (Bodelier et al. 1998). As* G. maxima *increases in a habitat, the availability of nitrogen in the soil could decrease.*

Environmental Impact Total	3
Total Unknowns (U)	2

Scoring

Score	# U's	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Reduced flow rates in water ways from siltation and debris build-up also creates breeding habitat for mosquitoes (Department of Primary Industries 2012).

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Large communities of G. maxima *can impede water flow, alter hydrology and even restrict access to natural waterways, and irrigation or drainage channels. In Tasmania, populations of* G. maxima *have created so much additional silt (from reduced water flow) that shallow dams have become useless (Department of Primary Industries 2012).*

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1

Not significantly	0 √
Unknown	U

Glyceria maxima *has been used as forage, however cattle may experience cyanide poisoning if allowed to graze on young shoots (Boos et al. 2010, King County 2012).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

In areas where G. maxima *could begin growth early in the season it can out-compete* Phragmites australis *(Studer-Ehrenseberger et al. 1993).*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1 √
Not significantly	0
Unknown	U

Sold and used as an ornamental (King County 2012).
Used in wastewater treatment in some European countries (Harrington et al. 2012, Sundblad and Robertson 1988)

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Glyceria maxima *tolerates low oxygen concentrations and it thrives in eutrophic environments, making it an ideal species for artificial wetland systems (Sunblad and Robertson 1988).* Glyceria maxima *has been used to treat the wastewaters from swine farms in integrated constructed wetlands (ICW) in Ireland. During an 18-month study, the ICW successfully removed 98.1-99.9% of the ammonia-nitrogen (Harrington et al. 2012). In other ICWs planted with only* G. maxima*, there was significant reduction in total organic nitrogen, ammonia-nitrogen, nitrate-nitrogen and molybdate reactive phosphorus (Harrington and Scholz 2010). In experiments by Sundblad and Robertson (1988) in the Czech Republic, harvesting* G. maxima *may increase the nutrient recovery from the wastewater.*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	<u>**Low**</u>

1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Hydrocharis morsus-ranae* L.

Common Name: Common frogbit

Environmental: Moderate
Socio-Economic: Moderate
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

This species is also capable of aggressive growth: one hibernaculum (starting material for a new plant) can grow to cover an area one diameter in diameter in a single season (Haynes 1988).
The free-floating form can lead to densely tangled floating mats, which can crowd and shade out native aquatic vegetation (Catling et al. 2003, Grant 2013).
Populations of H. morsus-ranae *can also compete for nutrients and gases; further reducing the growth of nearby vegetation (Lui et al. 2010).*
There was a 95% decline submerged vegetation species below mats of H. morsus-ranae *(Catling et al. 1988 in Mudrzynski et al. 2011).*
There are discrepancies regarding the extent of H. morsus-ranae *in the Great Lakes. Trebitz and Taylor (2007) state that this species rarely becomes dominant in Lakes wetlands. However, there have also been reports that* H. morsus-ranae *population have been aggressively growing in large areas of shallow, open waters in Michigan (Reznicek et al. 2011).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1 √
Not significantly	0

Unknown	U

As colonies H. morsus-ranae *displace native plants; other native aquatic life experience a reduction in food and habitat (Environment Canada 2003, WI DNR 2012).*
Dense mats can inhibit the movement of waterfowl or larger fish; which could alter predator/prey cycles as the waterfowl and fish move to other locations to find food (O'Neill Jr. 2007, University of Minnesota, Wisconsin Sea Grant Institute 2012).
Catling et al. (1988) surveyed life H. morsus-ranae *mats and found a decline in snails, crustacean, and insect larvae (in Mudrzynski et al. 2011).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

In the autumn, H. morsus-ranae *dies and sinks to the bottom of the water body, where it decomposes (IL DNR 2009). Altered hydrology and/or increased decomposition can reduce oxygen concentration in nearby waters and could potentially lead to the death of nearby plants, insects or fish and insects (Catling et al. 2003, IL DNR 2009). However, Thomas and Daldorp (1991) found that the addition of the* H. morsus-ranae *had no effect on the macrophyte community or on the dissolved oxygen profiles.*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Dense stands can alter the water flow or currents (Mikulyuk and Nault 2011).

Environmental Impact Total	3
Total Unknowns (U)	2

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Large infestations of H. morsus-ranae *have reduced water currents in canals and irrigation systems (Catling et al. 2003).*

Dense layers of tangled stems and roots can wrap about boat propellers and impede water traffic (Lui et al. 2010, University of Minnesota Wisconsin Sea Grant Institute 2012).

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

Large populations of common frogbit also limit recreational activities such as swimming, fishing, and waterfowl hunting (Grant 2013, Lui et al. 2010, University of Minnesota Wisconsin Sea Grant Institute 2003).
The decreased recreational and aesthetic value linked to large populations of H. morsus-ranae *can… even cause declines in tourism and associated revenue (Mikulyuk and Nault 2011).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

The decreased recreational and aesthetic value linked to large populations of H. morsus-ranae *can lead to a reduction in property value along the affected waterfront… (Mikulyuk and Nault 2011).*

Socio-Economic Impact Total	3
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**<u>Moderate</u>**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

<u>BENEFICIAL EFFECT</u>

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6

Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Some property owners consider it to have aesthetic appeal and is used in water gardens (New York Invasive 2012).

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Spermidine, an anti-aging compound, can be found in dormant turions of H. morsus-ranae *(Villanueva et al. 1985).*
Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1 √
Not significantly	0
Unknown	U

Some species of water birds, fish, and insects feed on H. morsus-ranae *(O'Neill Jr. 2007).*

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Impatiens glandulifera* Royle

Common Name: Ornamental jewelweed

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Impatiens glandulifera *is considered to be one of the most invasive plants of the world (Weber 2000 in Vervoort et al. 2011).*
It is able to out-compete beneficial, and often native, plants for physical space, light, and nutrients (Tanner 2011). Early spring emergence, plus the ability to capitalize on disturbance opportunities, can lead to dense monospecific stands (Perrins et al. 1993).
As access to nutrients increases, I. glandulifera *individuals will allocate extra resources and energy for seed production (Willis and Hulme 2004).*
However, studies of six riparian communities in the Czech Republic indicated that I. glandulifera *has a negligible effect on existing communities and therefore is not a threat to plant diversity there (Hejda and Pyšek 2006).*
Preferential visitation of ornamental jewelweed by pollinators could ultimately lead to a reduction in fitness of neighboring species (Chittka and Schürkens 2001 in Tanner 2011). In a study conducted by Vervoort et al. (2011) in Belgium, I. glandulifera *was visited by potential pollinators up to 250 times—substantially more than other* Impatiens *species studied (< 10 visits). However, in a study conducted in Germany, there was no significant evidence to suggest that* I. glandulifera *out-competes native plants for pollinators during periods of simultaneous blooming (Bartomeus et al. 2010).*
Due to its genetic variation, I. glandulifera *has the ability to adapt to local environments within a few generations and has a strong probability of expanding northward into previously unoccupied niches (Kollmann and Bañuelos 2004). Ornamental jewelweed also seems to react positively to increases in carbon dioxide and temperature. With increasing global mean temperature,* I. glandulifera *could expand its range northward by several degrees latitude (Beerling 1993).*
Even though impacts of I. glanulifera *have been studied in detail elsewhere, the extend of the impacts in the Great Lakes are not as well documented.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

As native plants become displaced, specialized herbivorous insects leave the area and subsequently lead to a shift in the predatory insect community (e.g., spiders). There is the potential for further trophic shifts, as well (Tanner 2011).
However, alterations to predator-prey cycles or trophic shifts have not been recorded in the Great Lakes.

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0

Unknown	U

If it displaces perennial vegetation along water bodies, soil erosion is likely to occur (IPANE 2004).
The adventitious roots of ornamental jewelweed can obstruct waterways and wetlands, which can alter hydrology of the ecosystem. This altered hydrology can lead to increased erosion or flooding (Forest Service 2007, King County 2007). A larger sediment load in the river could in turn reduce available habitat and smother benthic communities (Tanner 2011).
At maturity, ornamental jewelweed is taller and has relatively larger leaves than most grasses and forbs. This shading effect creates bare patches nearby, facilitating germination and emergence of additional I. glandulifera *seedlings (Centre for Aquatic Management 2004, King County 2007).*
The stems of I. glandulifera *have high holocellulose content (insoluble carbohydrates) that does not fully decompose over the winter. As a result, litter still present in the spring can suppress other plant seedlings (Beerling and Perrins 1993).*

Environmental Impact Total	1
Total Unknowns (U)	2

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	**Unknown**
1	≥1	**Unknown**

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed	1

AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1 √
Not significantly	0
Unknown	U

When I. glandulifera *and* Lythrum salicaria *(purple loosestrife, another major invasive of the Great Lakes) share a pollinator community,* I. glandulifera *will out-compete* L. salicaria *for pollinators, ultimately decreasing pollen deposition and seed production in the latter (Thijs et al. 2012).*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

In the Czech Republic, I. glandulifera *is an important source of nectar and pollen because its bloom period lasts longer than many of the native plant species. Starý and Taklců (1998) have concluded that the present of* I. glandulifera *has contributed to the conservation of several bumble-bee species.*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact

>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Iris pseudacorus*

Common Name: Yellow iris

Environmental: High
Socio-Economic: Moderate
Beneficial: Moderate

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Yellow iris contains glycosides that can cause skin irritation in wildlife that come in contact with this plant; animals can also experience non-fatal poisoning if plant matter is ingested (Lui et al. 2010).

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6 √
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U

Iris pseudacorus *is tolerant of a range of water conditions (salinity, poor water quality, drought) that enable it to be a good competitor in a variety of wetland ecosystems (Sarver et al. 2008).*
The clonal nature of I. pseudacorus *causes it to form dense stands and thick, submerged rhizome mats (Idaho Invasives 2007, Lui et al. 2010) that can prevent the germination and growth of native species (sedges, rushes, etc.) and eventually displace them entirely (Lui et al. 2010, MNDNR 2012, Noxious Weed Control Program 2009, ODA 2012).*
Iris pseudacorus *can also out-compete neighboring plants for pollinators (Dieringer 1982).*
Iris pseudacorus *may be a competitive threat to native irises, including* I. brevicaulis *(listed as threatened in Ohio),* I. cristata, I. lacustris *(endemic to the Great Lakes),* I. robusta [versicolor x virginica] *(endemic to the Great Lakes),* I. setosa, I. verna *(listed as threatened in Ohio),* I. versicolor, I. virginica, *and* I. virginica *var.* shrives *(USDA and NRCS 2012, ODNR 2012).*
In wetland ecosystems in the eastern United States, I. pseudacorus *has reduced the density of native sedges and rushes that serve as habitat for other species, especially waterfowl (Jacobs et al. 2011).*
In Connecticut, I. pseudacorus *successfully excluded native arrow-arum (*Peltandra virginica*), which is an important food source for nesting wood ducks (Cox 1999).*
By 1970, yellow iris was found growing to the complete exclusion of Typha *and other native marsh plants along the Merced River in California (Raven and Thomas 1970). It later expanded along 1300 miles of irrigation canals and laterals near Flathead Lake in northwestern Montana (Lake County Weed District, Pablo, Mont., pers. comm. 2001).*
Yellow iris has a high anoxia tolerance. During the growing season, it can survive at least 28 days of dark and anoxia; this period is increased to 60 days for overwintering plants (Schlüter and Crawford 2001). When exposed to

prolonged periods of anoxia, I. pseudacorus *increased production of superoxide dismutase enzymes that help the plant cope with oxidative stress (drought, nutrient deficiencies, injury, etc.) (Monk et al. 1987). The ability to cope with and recover from stress faster than neighboring plants may enable it to be a better competitor.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Populations of yellow iris create a positive feedback loop: once established, the roots trap sediment, which enables growth of new seedlings, which in turn trap more sediment (Jacobs et al. 2011). This increase in sedimentation also creates new habitat for shrubs and trees, thereby altering it to a drier ecosystem (Lui et al. 2010, Sarver et al. 2008). This alteration reduces the food supply and nesting habitat of many fish and waterfowl that depend on wetlands (Noxious Weed Control Program 2009, ODA 2012).
Such alterations have not been documented in the Great Lakes.

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR	6

Yes, and it has resulted in significant negative consequences for at least one native species	
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

The vegetative growth of yellow iris can trap sediment, raise local elevation of the ecosystem, and alter wetland hydrology (Noxious Weed Control Program 2009, Sarver et al. 2008). Increase in sedimentation also creates new habitat for shrubs and trees, thereby altering it to a drier ecosystem (Lui et al. 2010, Sarver et al. 2008).

Environmental Impact Total	8
Total Unknowns (U)	3

Scoring		
Score	# U	Impact
>5	Any	**<u>High</u>**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

<u>SOCIO-ECONOMIC IMPACT</u>

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

All parts of I. pseudacorus *are poisonous (Idaho Invasives 2007). Resins can cause skin irritation and blistering; if ingested, this plant will cause gastric distress in humans (ISCBC 2012, Lui et al. 2010, Sutherland 1990).*

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Stands of I. pseudacorus *can reduce flow and block irrigation systems and flood control ditches (Noxious Weed Control Program 2009, ODA 2012).*
Its seeds can clog pipes and water control structures (Noxious Weed Control Program 2009).
Removal of plant material from these systems may require herbicides or excavation equipment and can be costly (ODA 2012).

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Yellow iris (live or dried) can cause gastroenteritis in cattle and sicken other livestock if ingested, although grazing animals tend to avoid it (Lui et al. 2010, Sutherland 1990).
Because palatable species go relatively untouched when intermingled with I. pseudacorus*, the quality of pastureland can be reduced (Bossuyt et al. 2005).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	3
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**<u>Moderate</u>**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1 √
Not significantly	0
Unknown	U

Iris pseudacorus *is a popular ornamental plant.*
Historically, the flowers of I. pseudacorus *has been used to make a yellow dye, and the rhizomes were used as a powerful herbal laxative and emetic (Jacobs et al. 2011).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Ripe seeds, if well roasted before consumption, can be a substitute for coffee (Sturtevant and Hedrick 1972).

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Water-soluble polysaccharides extracted from I. pseudacorus *appear promising for pharmaceutical uses (Sanavova and Rakhimov 2004).*
Ethanol extracts of I. pseudacorus *show larvicidal and mirscidiacidal/cercarcidal (compounds that kills trematode larvae) properties (Ahmed and Hamshary 2005).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0
Unknown	U √

Many studies have investigated the use of I. pseudacorus *in wastewater treatment to reduce total nitrogen and total phosphorus concentration, and some treatment wetlands in the Czech Republic already use this species (Benson et al. 2004, Vymazal and Kröpfelová 2008). Wu et al. (2011) claimed that* I. pseudacorus *is a preferred plant species for treatment wetlands in Northern China because of its ability to uptake nutrients and its pleasant appearance. Barbolani et al. (1986) determined that* I. pseudacorus *was able to uptake cadmium and copper from contaminated* *waters, with a preference to uptake copper. Yellow iris is able to absorb these metals in proportion to what is available in the environment, with stands exposed to higher initial metal concentrations tending to absorb more metal than stands exposed to lower concentrations (Barbolani et al. 1986).* Iris pseudacorus *was able to remove copper from solutions that also contained surfactants and chlorides (Piccardi and Clauser 1983).* Iris pseudacorus *may be an economic choice for treatment wetlands designed to treat complex, urban wastewaters that contain heavy metals (Larue et al. 2010, Piccardi and Clauser 1983, Zhang et al. 2007). The rhizomes of* I. pseudacorus *can also reduce populations of* Escherichia coli*,* Salmonella*, and* Enterocoli *by 50-70% in a 24 hour period (Jacobs et al. 2011).*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1 √
Not significantly	0
Unknown	U

It can be planted along slopes and shores to prevent erosion control (Jacobs et al. 2011).
Muskrats use this species for building their dens (Jacobs et al. 2011).

Beneficial Effect Total	2
Total Unknowns (U)	1

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

Scientific Name: *Juncus compressus* Jacq.

Common Name: flattened rush

Environmental: Moderate
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

Once this species establishes in an ecosystem, it will likely persist (Stuckey 1981 in Vincent and Cusick 1998). In wetland environments, rushes will out-compete other plant species (Stevens and Hoag 2003).
Juncus compressus *poses a competitive threat to the native and naturalized* Juncus *spp. in the Great Lakes, especially those listed as threatened or endangered including* J. alpinus *auct. non Vill., J. ambiguus Guss.*, J. balticus *Willd., J.biflorus Elliot*, J. marginatus *Rostk. var. biflorus (Elliot) Alph. Wood*, J. brachycarpus *Engelm.*, J. brachycephalus *(Engelm.) Buchenau*, J. dichotomus *Elliot*, J. diffusissimus *Buckley*, J. ensifolius *Wikstr.*, *J. greenei Oakes & Tuck.,* J. interior *Wiegand*, J. militaris *Bigelow*, J. pelocarpus *E. Mey.*, J. scirpoides *Lam.*, *J. secundus P. Beauv. ex Poir.*, J. stygius *L.*, J. stygius L. ssp. americanus *(Buchenau) Hultén*, *J. subcaudatus (Engelm.) Coville & S.F. Blake,* J. vaseyi *Engelm. (USDA NRCS 2012c).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

There are no known records of hybrids between J. compressus *and other species, but this genus contains several natural hybridizations (USDA NRCS 2012a). Furthermore, several species of this genus have synchronous flowering to attract pollinators, which creates the potential for outcrossing (Michalski and Durka 2007).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

In the United Kingdom, the roots of Juncus spp. *have been observed to trap water and alter the hydrology in shallow water environments (Centre for Aquatic Plant Management 2004).*

Environmental Impact Total	2
Total Unknowns (U)	2

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low

1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1√
Not significantly	0
Unknown	U

Many Juncus *spp. serve as a host for larvae of* Coquillettidia, *a genus of mosquitoes that can serve as a vector for various animal-borne vectors (Sérandour et al. 2010).*

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √

Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Juncus compressus *may be confused with or pose a competitive threat to rushes that are culturally important, including* J. arcticus ssp. littoralis *and* J. effusus (USDA NRCS 2012b).

Socio-Economic Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Cattle, horses, and sheep will graze on Juncus spp., *but their specific value as fodder is unknown (Centre for Aquatic Plant Management 2004, Cosyns et al. 2005).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

The rhizome matrix can support numerous bacteria, which can be used in wastewater treatment (Stevens and Hoag 2003).

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1 √
Not significantly	0
Unknown	U

Numerous animals feed on the seeds of rushes, including waterfowl, songbirds, quail, cottontail, muskrat (also feeds on roots and rhizomes), porcupine, and other small mammals (Martin 1951 in Stevens and Hoag 2003).
Juncus *spp. provide habitat for amphibians and various wetland birds, as well as spawning ground for some fish species (Stevens and Hoag 2003).*
The dense root and rhizome system of Juncus spp. enable them to survive periods of stress (drought, flood, etc.), accumulate soil, and provide erosion control (Stevens and Hoag 2003).

Beneficial Effect Total	1
Total Unknowns (U)	0

<table>
<tr><th colspan="3">Scoring</th></tr>
<tr><td>Score</td><td># U</td><td>Impact</td></tr>
<tr><td>>5</td><td>Any</td><td>High</td></tr>
<tr><td>2-5</td><td>Any</td><td>Moderate</td></tr>
<tr><td>0</td><td>0-1</td><td rowspan="2"><u>Low</u></td></tr>
<tr><td>1</td><td>0</td></tr>
<tr><td>0</td><td>≥2</td><td rowspan="2">Unknown</td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

Scientific Name: *Juncus gerardii* Loisel.

Common Name: black-grass rush

Environmental: Moderate
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

Juncus gerardii *cannot invade areas with existing vegetation or dense litter (Ericson 1981 in Jutila 1999).* Juncus gerardii *seedlings also have little resistance to burial by wrack (floating plant material); significant amounts can lead to burial and ultimately seedling death (Brewer et al. 1998). For these reasons,* J. gerardii *becomes established in the first stages of succession after a disturbance (Bouzillé et al. 1997). Once established, this species can dominate terrestrial borders of high marshes and displace native species, such as* Spartina patens *(Bertness 1991 in Charpentier et al. 1998, Levine et al. 1998).*
Juncus gerardii *poses a competitive threat to the native and naturalized* Juncus *spp. in the Great Lakes, especially those listed as threatened or endangered, including* J. alpinus *auct. non Vill.*, J. ambiguus *Guss*., J. balticus *Willd*., J. biflorus *Elliot*, J. marginatus Rostk. var. biflorus *(Elliot) Alph. Wood*, J. brachycarpus *Engelm*., J. brachycephalus *(Engelm.) Buchenau*, J. dichotomus *Elliot*, J. diffusissimus *Buckley*, J. ensifolius *Wikstr*., J. greenei *Oakes & Tuck*., J. interior *Wiegand*, J. militaris *Bigelow*, J. pelocarpus *E. Mey*., J. scirpoides *Lam*., J. secundus *P. Beauv. ex Poir.*, J. stygius L., J. stygius L. ssp. americanus *(Buchenau) Hultén*, J. subcaudatus (*Engelm.) Coville & S.F. Blake*, J. vaseyi *Engelm. (USDA NRCS 2012c).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR	1

Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

There are no known records of hybrids between J. gerardii *and other species, but this genus contains several natural hybridizations (USDA NRCS 2012a). Several species of this genus have synchronous flowering to attract pollinators, which creates potential for outcrossing (Michalski and Durka 2007). However, Bouzillé et al. (1997) determined that sexual reproduction and seed dispersal had little significance on total reproduction and expansion of communities of* J. gerardii.

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

In the United Kingdom, the roots of Juncus *spp. have been observed to trap water and alter the hydrology in shallow water environments (Centre for Aquatic Plant Management 2004).*

Environmental Impact Total	2
Total Unknowns (U)	2

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**<u>Moderate</u>**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

<u>SOCIO-ECONOMIC IMPACT</u>

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Many Juncus spp. *serve as a host for larvae of* Coquillettidia, *a genus of mosquitoes that can serve as a vector for various animal- and human-borne vectors (Sérandour et al. 2010).*
The vegetative parts of J. gerardii *are round, stiff, and sharp enough to puncture human skin (College of Environment 2012).*

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Juncus gerardii *may be confused with or pose a competitive threat to rushes that are culturally important, including* J. arcticus ssp. littoralis *and* J. effusus (*USDA NRCS 2012b).*

Socio-Economic Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Cattle, horses, and sheep will graze on Juncus spp., *but their specific value as fodder is unknown (Centre for Aquatic Plant Management 2004, Cosyns et al. 2005).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

The rhizome matrix can support numerous bacteria that are useful in wastewater treatment (Stevens and Hoag 2003).

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1 √
Not significantly	0
Unknown	U

Numerous animals feed on the seeds of rushes, including waterfowl, songbirds, quail, cottontail, muskrat (also feeds on roots and rhizomes), porcupine, and other small mammals (Martin 1951 in Stevens and Hoag 2003).
Juncus *spp. provide habitat for amphibians and various wetland birds, as well as spawning ground for some fish species (Stevens and Hoag 2003).*
The dense root and rhizome system of Juncus spp. enable them to survive periods of stress (drought, flood, etc.), accumulate soil, and provide erosion control (Stevens and Hoag 2003).

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown

1	≥1	

Scientific Name: *Juncus inflexius* L.

Common Name: European meadow rush

Environmental: Moderate
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

Once this species establishes in an ecosystem, it will likely persist (Stuckey 1981 in Vincent and Cusick 1998). Under ideal conditions, J. inflexus *can live up to 8 years (Chalet Nursery 2012).In wetland environments, rushes will out-compete other plant species (Stevens and Hoag 2003).*
Juncus inflexus *tends to have a significant presence in the seed bank in areas of intensive agriculture (Reiné et al. 2004).*
Juncus inflexus *poses a competitive threat to the native and naturalized* Juncus spp. *in the Great Lakes, especially those listed as threatened or endangered, including* J. alpinus auct. non Vill., J. ambiguus Guss., J. balticus Willd., J. biflorus Elliot, J. marginatus Rostk. var. biflorus (Elliot) Alph. Wood, J. brachycarpus Engelm., J. brachycephalus (Engelm.) Buchenau, J. dichotomus Elliot, J. diffusissimus Buckley, J. ensifolius Wikstr., J. greenei Oakes & Tuck., J. interior Wiegand, J. militaris Bigelow, J. pelocarpus E. Mey., J. scirpoides Lam., J. secundus P. Beauv. ex Poir., J. stygius L., J. stygius L. ssp. americanus (Buchenau) Hultén, J. subcaudatus (Engelm.) Coville & S.F. Blake, J. vaseyi Engelm. (*USDA NRCS 2012c).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of	1

which have not been widespread or severe	
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Juncus inflexus *also poses a genetic threat, because hybrids with* J. effusus *are possible when these species grow in the same location (Clifford 1958). Several species of this genus have synchronous flowering to attract pollinators, which creates potential for outcrossing (Michalski and Durka 2007).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1√
Not significantly	0
Unknown	U

In the United Kingdom, the roots of Juncus *spp. have been observed to trap water and alter the hydrology in shallow water environments (Centre for Aquatic Plant Management 2004).*

Environmental Impact Total	2
Total Unknowns (U)	1

Scoring		
Score	# U	Impact
>5	Any	High

2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Many Juncus *spp. serve as a host for larvae of Coquillettidia, a genus of mosquitoes that can serve as a vector for various animal- and human-borne vectors (Sérandour et al. 2010).*

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6

Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Juncus inflexus *may be confused with or pose a competitive threat to rushes that are culturally important, including* J. arcticus ssp. littoralis and J. effusus (USDA NRCS 2012b).

Socio-Economic Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Cattle, horses, and sheep will graze on Juncus *spp., but their specific value as fodder is unknown (Centre for Aquatic Plant Management 2004, Cosyns et al. 2005).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √

Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

After 20 days of exposure, J. inflexus *was able to remove all 100 mg/L of ethylene glycol dinitrate (EGDN), an explosive ingredient in dynamite, from in vitro regenerants (Podlipná et al. 2010). However, when exposed to 500 mg/L,* J. inflexus *began to die (Podlipná et al. 2008).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

The rhizome matrix can support numerous bacteria that are useful in wastewater treatment (Stevens and Hoag 2003).

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1 √
Not significantly	0
Unknown	U

Juncus inflexus *can be planted in rain gardens and for erosion control (Missouri Botanical Garden 2012). Numerous animals feed on the seeds of rushes, including waterfowl, songbirds, quail, cottontail, muskrat (also feeds on roots and rhizomes), porcupine, and other small mammals (Martin 1951 in Stevens and Hoag 2003).*
Juncus *spp. provide habitat for amphibians and various wetland birds, as well as spawning ground for some fish species (Stevens and Hoag 2003).*

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Lupinus polyphyllus*

Common Name: Lupine

Environmental: Unknown
Socio-Economic: Low
Beneficial: Moderate

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)? √

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Twenty-nine quinolizidine alkaloids have been found and characterized from the combined leaf/hypocotyl extracts of Lupinus polyphyllus (Veen et al 1992). Alkaloids present in the plant are mildy toxic and cause a bitter taste. Most herbivores quickly learn to avoid them, consumption (including in hay) may be harmful to sheep and cattle.

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

It can outcompete native species occurring in road verges, ruderal areas, gravelly floodplains and other open habitats.
Lupin alkaloids are also allelopathic, inhibiting germination of many seeds, and L. polyphyllus *may outcompete native plants via this mechanism (Wink 1983, Muzquiz et al 1994).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or	6

extinction of one or more native species	
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Lupinus polyphyllus *is known to hybridize with other lupines. It is unknown whether it is hybridizing with the sundial lupine* (Lupinus perennis) *native to the Great Lakes region.*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Due to the nitrogen-fixing nodules L.polyphyllus *changes the soil chemistry in favour of nitrogen-demanding species. Thus,* L. polyphyllus *causes a change in nutrient content of soil and, eventually, in plant communities. Eutrophication of nutrient-poor sites and consequent changes in community structure and diversity is the main problem when* L. polyphyllus *invades an area.*

Environmental Impact Total	1
Total Unknowns (U)	2

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	**Unknown**
1	≥1	**Unknown**

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Lupine contamination of hay raises alkaloid content and may negatively impact the usefulness of hay as fodder and hence its value.

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1 √
Not significantly	0
Unknown	U

Several cultivars are considered valuable garden plants. It has also been widely used as a 'green fertilizer' due to its ability to support nitrogen fixation. Low alkaloid cultivars have been developed for use as forage crops.

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1 √
Not significantly	0
Unknown	U

Several cultivars are popular garden plants.

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR	1

It is potentially important to medicine or research and is currently being or scheduled to be studied	
Not significantly	0 √
Unknown	U

Lupinus polyphyllus *extracts (from low alkaloid cultivars) are sold as 'herbal medicines'. Lupine seeds (also from low alkaloid cultivars) are cultivated for the edible seeds.*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Lupine absorbs radiation well and has been planted around Chernobyl for bioremediation. [source not confirmed]

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	2
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**<u>Moderate</u>**
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

Scientific Name: *Lycopus asper*

Common Name: Western water horehound

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Lycopus asper *is found in industrialized areas, polluted habitats and other man made habitats.*
It is now frequent in the western Lake Erie area and local elsewhere in wet ground, especial disturbed shores and ditches (Reznicek et al. 2011). In a survey of fens in Ohio, Lycopus *spp. Constituted less than 2% of vegetation cover (Barry et al. 2008).*
Lycopus asper *could pose a competitive threat to native species:* L. americanus Muhl. Ex W. Bartram, L. amplectens Raf., L. rubellus Moench, L. uniflorus Michx., and L. virginicus L. *(USDA NRCS 2012).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the	6

decline or extinction of one or more native species	
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	2

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Lycopus europaeus*

Common Name: European water horehound

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Stammel et al. (2003) report that L. europaeus *possess a chemical compound that may be effective against herbivores in the Great Lakes.*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Lycopus europaeus *invades numerous wetland ecosystems and is capable of displacing natives, such as:* L. americanus Muhl. Ex W. Bartram, L. amplectens Raf., L. rubellus Moench, L. uniflorus Michx., and L. virginicus *L. (USDA NRCS 2012).*
In its native range European water horehound is a common, widespread species that can come to dominate in some ecosystems (Lucassen et al. 2006, van der Valk and Verhoeven 1988).
A majority of seeds collected during a survey of moving bodies of water in the Netherlands were from L. europaeus. *This species also had the highest germination rate of all the seeds collected (Boedeltje et al. 2003).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Hybridization between L. europaeus *and* L. americanus *can occur when both species are living in close proximity. Hybrids have been found in North America; however, there are no records of hybrids in the Great Lakes (Reznicek et al. 2011).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	1
Total Unknowns (U)	3

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**

1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Lycopus europaeus *can be found in brick and concrete wall structures in urban environments (Francis and Hoggart 2011). Over time these structures could weaken.*

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Historically, L. europaeus *has been used as an astringent, cosmetic, douche, narcotic, refrigerant and to treat fever, sores, and wounds.*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √

Not significantly	0
Unknown	U

Six isopimarane diterpeniods, which are frequently used in pharmaceuticals, have been isolated from L. europaeus *(Hussein et al. 1999).*
A diterpenoid isolated from L. europaeus, *euroabienol, showed activity against 15 strains of bacteria and 6 fungal strains. Euroabienol has great potential to be used as a broad spectrum antibiotic and/or antifungal (Radulović et al. 2010).*
Gibbons et al. (2003) found that diterpenes from L. europaeus, *when combined with other compounds, have potential at regulating bacteria that have resistance to multiple drugs.*
Polar extracts from L. europaeus *contain flavonoids and phenolic acids; both of which are antioxidants (López et al. 2007).*
Another polyphenolic compound extracted exhibits the potential to influence the thyroid glands and gonads (Fecka and Cisowski 1999).
Mild forms hyperthyroidism can be improved by taking extracts from L. europaeus *(Beer et al. 2008, Wojciechowski et al. 2003). Patients who are given low doses of* L. europaeus *experience reduced levels of thyroid hormone and reduced cardiac symptoms (Vonhoff et al. 2006).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	**0-1**	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Lysimachia nummularia* L.

Common Name: moneywort

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Lysimachia *spp. are susceptible to rust and leaf spots (Missouri Botantical Garden 2012).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

Lysimachia nummularia *spreads quickly in moist ecosystems: floodplain forests, prairies, marshes, and swamps (IPANE 2013, Kennay and Fell 2011).*
This species forms dense mats of vegetation that excludes other herbaceous vegetation (IPANE 2013, Kennay and Fell 2011).
It may occupy the same niche as Lysimachia radicans, *which is endangered in Indiana (Indiana Natural Hertiage Database 2011).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

This species is not a preferred food source for any mammal species, but rabbits and ground hogs may eat it occasionally (Kennay and Fell 2011).

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Populations of moneywort can clog small springs (IPANE 2013).

Environmental Impact Total	1
Total Unknowns (U)	3

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1

Not significantly	0 √
Unknown	U

Historically it has been used as groundcover in the Northeast, but it quickly becomes a pest in gardens, pastures, and lawns (IPANE 2013).

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

This species has been used for ornamental purposes because the attractive yellow flowers of Lysimachia nummularia occasionally *attract bees (Missouri Botanical Garden 2013).*

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0

Unknown	U

Saponins taken from the roots of L. nummularia *suppress cancer cells growing in the prostate, brain, and lungs (Podolak et al. 2013).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Lysimachia nummularia *is able to bioaccumulate mercury (Ribeyre and Boudou 1994).*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

Scientific Name: *Lysimachia vulgaris* **L.**

Common Name: yellow loosestrife

Environmental: Moderate
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Lysimachia vulgaris *is an unpatalable species that is avoided by large herbivores due to toxic compounds (Bossuyt et al. 2005).*
Lysimachia spp. *are susceptible to rust and leaf spots (Missouri Botanical Garden 2012).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

In Washington, yellow loosestrife has displaced native vegetation in wetlands and along streambanks and reduced habitat for waterfowl and fish (King County 2010).
Yellow loosestrife has also been observed outcompeting purple loosestrife (Lythrum salicaria); a very problematic weed that is also found in the Great Lakes (State of Washington 2013).
Bossuyt et al. (2005) observed that plant populations dominated by L. vulgaris *had decreased total species richness compared to populations nominated by other invasive plant species.*
It may occupy the same niche as Lysimachia radicans, *which is endangered in Indiana (Indiana Natural Heritage Database 2011).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

It was also observed that when there was a majority of L. vulgarius *present, palatable plant species produced significantly more inflorescences (Bossuyt et al. 2005).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

This species can also create dense communities which alter the local hydrology by clogging shallow waterways and increasing sedimentation (King County 2010).

Environmental Impact Total	2
Total Unknowns (U)	3

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**<u>Moderate</u>**
0	0-1	Low
1	0	Low
0	≥2	Unknown

1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the	6

natural or cultural character of the area, or significantly reduced the area's value for future generations	
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Lysimachia vulgaris *has been used as a garden ornamental or for other landscaping purposes outside the Great Lakes (King County 2010).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0

Unknown	U

Extracts taken from L. vuglaris *contain many flavonoids; which have anti-oxidation properties (Rzadkowska-Bodalska and Olechnowicz-Stepień 1975).*
These flavanol glycosides are used in Chinese folk medicine to treat high blood pressure (State of Washington 2013).

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Lysimachia vulgaris *is an unpatalable species that is avoided by large herbivores due to toxic compounds (Bossuyt et al. 2005).*

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Lythrum salicaria*

Common Name: Purple Loosestrife

Environmental: High
Socio-Economic: Low
Beneficial: Unknown

ENVIRONMENTAL IMPACTS

Does the species pose some hazard or threat to the health of native species (e.g. it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g. limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g. habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g. critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6 √
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U

As it establishes and expands, it outcompetes and replaces native grasses, sedges, and other flowering plants that provide a higher quality source of cover, food, or nesting sites for native wetland animals (U.S.EPA 2008).

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g. added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR It has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1 √
Not significantly	0
Unknown	U

Habitat and foraging is reduced for a number of wildlife species including birds and waterfowl, insects, and other semi-aquatic species, and in some cases reduced wildlife diversity in the community is documented (Blossey et al., 2001, Malecki et al., 1993, Schooler et al., 2009, Whitt et al., 1999)

Has it affected any native populations genetically (e.g. through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the	6

decline or extinction of one or more native species	
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g. increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Areas dominated by purple loosestrife (Fig. 2) show significantly lower porewater pools of phosphate in the summer compared to areas dominated by Typha latifolia L. (Templer et al., 1998).
Purple loosestrife leaves decompose quickly in the fall resulting in a nutrient flush, whereas leaves of native species decompose in the spring (Barlocher and Biddiscombe, 1996; Emery and Perry, 1996; Grout et al., 1997).

Does it alter the physical ecosystem in some way (e.g. facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR It has resulted in significant negative consequences for at least one native species	6
Yes, it has affected they physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Purple loosestrife causes annual wetland losses of about 190,000 hectares in the United States (Thompson et al. 1987; Mal et al. 1997).
Change in timing of nutrient release to autumn, a time of little primary production, results in significant alterations of wetland function and could jeopardize detritivore consumer communities (Grout et al., 1997).

Environmental Impacts Total	9
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown

1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g. it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g. commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g. through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the	6

natural or cultural character of the area, or significantly reduced the area's value for future generations	
Yes, but negative consequences have been small	1
Not significantly	0√
Unknown	U

Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL IMPACT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g. for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g. for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
It is sometimes employed recreationally, but adds little value to local communities or tourism	1 √
Not significantly	0
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0
Unknown	U √

Does the species have a positive ecological impact outside of biological control (e.g. increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Positive Impact Total	1
Total Unknowns (U)	1

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

Scientific Name: *Marsilea quadrifolia* L.

Common Name: European waterclover
Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Marsilea quadrifolia *is capable of outcompeting native aquatic and moist terrestrial species and creating monotypic vegetative stands (Benson et al 2004, Illinois Department 2013).*
These monospecific stands can also persist throughout the winter seasons because of the underground rhizomes (Benson et al. 2004).
During the growing season M. quadrifolia *plants are able to adjust the angle of the floating leaflets to optimize access to sunlight and the ability to photosynthesize (Kao and Lin 2010). This ability could allow this species to outcompete neighboring species for sunlight.*
The presence of M. quadrifolia *in an aquatic ecosystem can also have an effect on molluscan communities (U.S EPA 2008).*
Other sources report that M. quadridfolia *does not spread aggressively and poses a small ecological threat (Benson et al. 2004, Connecticut Aquatic 2006)*
In a survey by Henry and Myers (1983), M. quadrifolia *only migrated 151 feet per year Spring Creek (Illinois); for a total range expansion of 1 mile downstream in 35 years.*
The New York Invasive Species Council ranks this species as posing an unknown ecological threat (New York Invasive 2010).

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which	1

have not been widespread or severe	
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

The native fern Marsilea vestita *is endangered in Minnesota (Illinois Department 1996).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	4

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	

0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

European waterclover is commonly used in water gardens and aquariums (Campbell et al. 2010).

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Marsilea quadrifolia *is an edible leafy plant with high crude protein content, but has a widely varying nutrient composition depending on the season it was harvested (Dewanji et al. 1993).*

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR	1 √

It is potentially important to medicine or research and is currently being or scheduled to be studied	
Not significantly	0
Unknown	U

Extracts from M. quadrifolia *reduced the severity of seizures in rats (Sahu et al. 2012).*
This species also possesses compounds that may act as acytylcholinesterase and butyrylcholinesterase inhibitors; which could play a role in the management of Alzheimer's disease (Bhadra et al. 2012).
In a study conducted by Ripe et al. (2009), extracts from M. quadrifolia *were found to have antibacterial, cytotoxic and antioxidant properties. These properties may be useful in antiproliferative, antitumor, and pesticidal applications (Meyer et al. 1982 in Ripe et al. 2009).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Marsilea quadrifolia *is an edible leafy plant with high crude protein content, but has a widely varying nutrient composition depending on the season it was harvested (Dewanji et al. 1993).*

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Mentha aquatica* L.

Common Name: watermint

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Mentha aquatica *can hybridize with* M. spicata *to result in* Mentha X piperita *(Gobert et al. 2002)*.

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	1
Total Unknowns (U)	5

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	**Unknown**
1	≥1	**Unknown**

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate

0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Historically, mint species have been used for medicinal and culinary purposes (Ohio State University 2012).

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

In Jordan M. aquatica, *in combination with other plant species, is used in numerous ways: as an expectorant, an astringent, a muscular relaxant for the uterus and arteries, a carminative, an antispasmodic, an antiepileptic, a narcotic, an antipyretic, a diaphoretic, a cathartic, a hypnotic, an anal gesic, an antineuralgic, an antiarthritic, an antirheumatic, and an antitussive (Al-Qura'n 2007).*
Extracts taken from M. aquatica *have shown to have selective antiproliferative activity on breast cancer, as well as neurochemical properties that may have medicinal purposes (Conforti et al. 2008, López et al. 2010).*
Essential oils derived from M. aquatica *have antimicrobial activity (Mimica-Dukić et al. 2003).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1

Not significantly	0 √
Unknown	U

Mentha aquatica *may also be able to uptake lead from its surrounding environment; depending on the local pH (Saygideger and Dogan 2005)*.

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Mentha gracilis*

Common Name: gingermint

Environmental: Unknown
Socio-Economic: Low
Beneficial: High

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

As a hybrid of the native wildmint (M. arvensis), *gingermint has the potential to impact wildmint populations.*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	0
Total Unknowns (U)	5

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Handling *plant may cause skin irritation or allergic reaction; (http://www.misin.msu.edu/facts/detail.php?id=96)*

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Known to carry or be susceptible to more than 20 plant viruses, including viruses such as strawberry latent ringspot viris (SLRSV), alfalfa mosaic, cucumber mosaic, tobacco mosaic, and tomato spotted wilt which are pests on other crops (Tzanetakis et al 2010b) Potential effects to these other susceptible crops is unknown.

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	1

Scoring

Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6 √
Yes, but its economic contribution is small	1
Not significantly	0
Unknown	U

Widely grown essential oil crops in more northern latitudes (Zheljazkov et al 2010)
Scotch spearmint is derived from a cross between field mint (Mentha arvensis L.) *and native spearmint and has organoleptic properties slightly different to that of native spearmint - scotch spearmint has 20% limonene of the total oil and native spearmint has only 8% limonene. (Poovaiah et al. 2006)*
In the United States, the cultivated area for mint is about 50,000 ha, with spearmint (M. spicata *and* M. gracilis) *representing 20% of the production area and the crop value. Oregon and Washington are the largest producers followed by Idaho, Indiana, Wisconsin, and Michigan. (Tzanetakis et al 2010b) The USDA (2008) estimates the direct value of the spearmint oil crop at $24 million.*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1 √
Not significantly	0
Unknown	U

Many cultivars are available to gardeners/hobbyist. The flowers attract many different kinds of butterflies and bees and it is a beautiful addition to any garden." (http://bygl.osu.edu/content/vegetable-mint-mentha-spp)

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6 √
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0
Unknown	U

"Mint has been used for thousands of years for anything from medicinal wraps to talismans that scare away demons. Today it is commonly used in cooking and tea for its distinctive flavor and calming scent" (http://bygl.osu.edu/content/vegetable-mint-mentha-spp)
Menthol is a mint product.

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0
Unknown	U √

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	13
Total Unknowns (U)	1

<table>
<tr><th colspan="3">Scoring</th></tr>
<tr><td>Score</td><td># U</td><td>Impact</td></tr>
<tr><td>>5</td><td>Any</td><td>High</td></tr>
<tr><td>2-5</td><td>Any</td><td>Moderate</td></tr>
<tr><td>0</td><td>0-1</td><td rowspan="2">Low</td></tr>
<tr><td>1</td><td>0</td></tr>
<tr><td>0</td><td>≥2</td><td rowspan="2">Unknown</td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

Scientific Name: *Mentha spicata*

Common Name: spearmint

Environmental: Unknown
Socio-Economic: Low
Beneficial: High

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	0
Total Unknowns (U)	6

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate

0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1 √
Not significantly	0
Unknown	U

The plant repels insects and was formerly used as a strewing herb. Rats and mice intensely dislike the smell of mint. PlantLife.org, 2013
The three major pure constituents extracted from the M. spicata *leaf EO were also tested individually against three mosquito larvae. The LC(50) values of carvone, cis-carveol, and limonene appeared to be most effective against* A. stephensi *(LC(50) 19.33, 28.50, and 8.83 ppm) followed by* A. aegypti *(LC(50) 23.69, 32.88, and 12.01 ppm), and* C. quinquefasciatus *(LC(50) 25.47, 35.20, and 14.07 ppm). The results could be useful in search for newer, safer, and more effective natural larvicidal agents against* C. quinquefasciatus, A. aegypti, *and* A. stephensi. *(Govindarajan 2012)*
The oils of R. officinalis, M. spicata, and O. majorana *showed strong repellency against the ticks. (El-Seedi 2012)*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6 √
Yes, but its economic contribution is small	1
Not significantly	0
Unknown	U

In the United States, the cultivated area for mint is about 50,000 ha, with spearmint (M. spicata *and* M. gracilis) *representing 20% of the production area and the crop value. Oregon and Washington are the largest producers followed by Idaho, Indiana, Wisconsin, and Michigan. (Tzanetakis et al 2010b) The USDA (2008) estimates the direct value of the spearmint oil crop at $24 million.*
"Grown commercially for the essential oil, which is used in gum." (New Mexico State University)
An essential oil is obtained from the whole plant. The oil is used commercially as a flavoring for toothpaste and confectionery, and is sometimes added to shampoos and soaps.

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6 √
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0
Unknown	U

Many cultivars are available to gardeners/hobbyist. The flowers attract many different kinds of butterflies and bees and it is a beautiful addition to any garden." (Ohio State University 2013)
"Herb gardens. Naturalize as a ground cover in moist informal areas such as pond/water garden margins or low open woodland areas.' (Missouri Botanical Gardens 2013)
The leaves of spearmint are edible raw or cooked. Having a strong spearmint flavor, they are used as a flavoring in salads or cooked foods. Spearmint leaves can be used whole, chopped, dried and ground, frozen, preserved in salt, sugar, sugar syrup, alcohol, oil, or dried. The leaves lose their aromatic appeal after the plant flowers. They are best dried by cutting just before, or right as the flowers open, about 1/2 to 3/4ths the way down the sock (leaving

smaller shoots room to grow). There is some dispute as to what drying method works best, some prefer different materials (such as plastic or cloth) and different lighting conditions (such as darkness or sunlight). The leaves are often used in 'mint sauce', which is used as a flavoring in meals. A herb tea is made from the fresh or dried leaves. It has a very pleasant and refreshing taste of spearmint, leaving the mouth and digestive system feeling clean. An essential oil from the leaves and flowers is used as a flavoring in sweets, ice cream, drinks etc. It has a spearmint flavor. (PlantLife.org, 2013)

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6 √
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0
Unknown	U

"Mint has been used for thousands of years for anything from medicinal wraps to talismans that scare away demons. Today it is commonly used in cooking and tea for its distinctive flavor and calming scent" (Ohio State University 2013)
Menthol is a mint product.
Spearmint is a commonly used domestic herbal remedy. A tea made from the leaves has traditionally been used in the treatment of fevers, headaches, digestive disorders and various minor ailments. The herb is antispasmodic, urine-inducing, restorative, stimulant, and has agents that prevent vomiting, that relieve and remove gas from the digestive system, and give tone and strength to the stomach.
Spearmint also stops gonorrhoea, fluor albus and immoderate flow of the period. A cataplasm of the green leaves applied to the stomach, is said to prevent vomiting, and to women's breasts prevents hardness and curdling of milk. Two or three drops of oil can be taken on a lump of sugar for flatulence. Adding eight drops of the oil to 1 pt (568 ml) of water makes Aqua menthae, or Mint Water, which can be given to babies with colic. The infusion of 1 oz (28 g) of dried herb to 1 pt (568 ml) of boiling water is also said to be excellent for nausea and wind. PlantLife.org, 2013
Further studies are needed to test the reliability of these results and the availability of spearmint as a drug for hirsutism. (Akdogan 2007)
M. spicata *or* M. × piperita *essential oils are safe and effective for antiemetic treatment in patients, as well as being cost effective (Tanyarani-Najaran 2013)*
The essential oils obtained from Foeniculum vulgare, Mentha piperita *and* M. spicata, O.cimum basilicum, Origanum majorana, O. onites, O. vulgare, *and* Satureja cuneifolia *as well as common essential oil components have shown notable inhibitory effects against 10 isolated strains of illness producing microorganisms. (Orhan 2011*
Spearmint (Mentha spicata L.) *essential oil has an antifungal effect on* Fusarium oxysporum f. sp. radicis-cucumerinum *the causal agent of stem and crown rot of greenhouse cucumber (Nosrati 2011)*
the flower hexane extract obtained from M.spicata *associated with* M. rotundifolia *presents an antineoplastic activity against KB and MCF-7, and an antiproliferative effect at a high concentration toward NIH 3T3 [experimental cancer cell lines]. (Begnini 2012)*
The majority of the tested essential oils exibited considerable inhibitory capacity against all the organisms tested, as supported by growth inhibition zone diameters, MICs and MBC's. Thyme, coriander and basil oils proved the best antibacterial activity, while thyme and spearmint (Mentha spicata) oils better inhibited the fungal species. (Lixandru 2010)
Extracts of Mentha spicata *have shown XO inhibtory activity, suggesting that they may be useful in the treatment of gout (Hudaib 2011)*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1 √
Not significantly	0

Unknown	U

Spearmint (Mentha spicata) *extracts contained a compound that induced cometabolism of a PCB (Gilbert and Crowley, 1997).*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	20
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

Scientific Name: *Myosotis scorpiodes*

Common Name: True forget-me-not

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

This species contains pyrrolizidine alkaloids that are toxic to mammals and can cause weight loss, poor body condition, and liver disease (DiTomaso and Healy 2007).

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Competes with native plants in wet areas (Ling 2010) and can form large monocultures (Mehrhoff et al. 2003); therefore, it has the potential to significantly reduce populations of native plant species, and it may change the density of vegetation.

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level	1

AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U √

Myosotis *has been documented to hybridize with other members of the genus, but it is not known whether or not it will hybridize with the natives* Myosotis laxa *(listed as endangered in Indiana),* Myosotis macrosperma, *or* Myosotis verna.

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	2

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	**Unknown**
1	≥1	**Unknown**

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1 √
Not significantly	0
Unknown	U

Cultivated as an ornamental plant.

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

The nectar and pollen attract pollinating insects (Plants for a Future 2010).

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1

Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Plants provide additional habitats for aquatic, winged insects (Ling 2010).

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Myosoton aquaticum*

Common Name: water chickweed

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	2

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**

1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Young leaves and stems are edible if cooked, but not of commercial value.

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6

Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

The nectar of the flowers attracts small bees and Syrphid flies; some bees may collect pollen, while flies occasionally feed on pollen. The caterpillars of several moth species probably feed on the foliage, like other chickweeds. The seeds of chickweeds are attractive to sparrows and other birds, while the foliage is eaten by rabbits. Because Water Chickweed frequently occurs in wetland habitats, its foliage is probably eaten by the Canada goose.

Beneficial Effect Total	0
Total Unknowns (U)	0

<table>
<tr><th colspan="3">Scoring</th></tr>
<tr><td>Score</td><td># U</td><td>Impact</td></tr>
<tr><td>>5</td><td>Any</td><td>High</td></tr>
<tr><td>2-5</td><td>Any</td><td>Moderate</td></tr>
<tr><td>0</td><td>0-1</td><td rowspan="2"><u>Low</u></td></tr>
<tr><td>1</td><td>0</td></tr>
<tr><td>0</td><td>≥2</td><td rowspan="2">Unknown</td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

Scientific Name: *Myriophyllum spicatum L.*

Common Name: Eurasian watermilfoil

Environmental: High
Socio-Economic: High
Beneficial: Moderate

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Myriophyllum spicatum *populations and stagnant water also create habitat for the parasites that cause swimmer's itch and mosquitoes (Jacobs and Margold 2009, OISAP 2013).*
In lab experiment, polyphenolic allelochemicals taken from M. spicatum, *inhibited the growth of green algae and cyanobacteria; such as* Microcystis aeruginosa (Leu et al. 2002, Nakai et al. 2012).
In studies in Finland, chemicals secreted by M. spicatum *caused high mortality (73% to 89%) of the mysids* Neomysis integer *and* Praunus flexuosus *(Lindén and Lethiniemi 2005).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

This species is tolerant of low water temperatures and begins to photosynthesize and grow early in the spring (IISCTC 2007, MISIN and MNFI 2013). This growth habit allows M. spicatum *to reach the water's surface before native plants and create a dense canopy to out-compete for sunlight and space (IL DNR 2009, Madsen et al. 1991, MISIN and MNFI 2013). This advantage allows Eurasian milfoil to form dense beds with stem densities in excess of 300/m2 in shallow water; essentially excluding other plant species (Aiken et al 1979).*
Although in small tank experiments the native northern watermilfoil (Myriophyllum sibiricum) *appears competitively superior, in the field, however,* M. spicatum *has replaced* M. sibiricum *over much of the temperate range of this species in North America (Valley and Newman 1998).*
Suppression of native plant communities in the field can happen in only a few years (GLIFWC 2006).
Myriophyllum spicatum *has difficulty becoming established in existing populations of native plants (IL EPA 1996, Michigan Sea Grant 2012). This species thrives in waterbodies that have experienced a disturbance: nutrient loading, intense plant management (i.e. yard management on private property), heavy recreational use, and/or fluctuating water levels (Benson et al. 2004, IL DNR 2009, Swearingen et al. 2002).*
Myriophyllum spicatum *is found in hundreds of Michigan inland lakes (Michigan Sea Grant 2007).*
The Minnesota Sea Grant states that Eurasian watermilfoil is not problematic in ecosystems with sandy or low sediment fertility (Jensen 2010).

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1 √
Not significantly	0
Unknown	U

Keast (1984) found that stands of Eurasian watermilfoil in lakes in Ontario had reduced abundance and diversity of aquatic insects and other benthic macroinvertebrates compared to native communities.
Keast (1984) also found that there were 3-4 times as many fish feeding in native plant communities than in beds of M. spicatum.
Dense cover allows high survival rates of young fish; however, larger piscivorous fish lose foraging space and are less efficient at obtaining their prey (Lillie and Budd 1992).
Madsen et al. (1995) found growth and vigor of a warm-water fishery reduced by dense Eurasian watermilfoil cover.
Myriophyllum spicatum *also has less value as a food source for waterfowl than the native plants it replaces (Aiken et al. 1979).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Myriophyllum spicatum *is capable of hybridizing with the native* M. sibiricum *to produce* M. sibricum X spicatum *which has an intermediate number of leaf segments between the two parent species (Reznicek et al. 2011).*
These hybrids have been found in Wisconsin (Moody and Les 2002, Ortenblad et al. 2006).
Any hybrid of M. spicatum *and a native milfoil could create a more aggressive species of invasive plant (Lui et al. 2010).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Altered hydrology (caused by M. spicatum*) can result in decreased dissolved oxygen levels and it can alter temperature and pH of the surrounding water (Engel 1995, GLIFWC 2006, Jacobs and Margold 2009)*

Myriophyllum spicatum *communities also impact nutrient cycling by uptaking phosphorus from the sediments and releasing them during fall senescence; which could contribute to eutrophication of ponds and lakes (GLIFWC 2006, Jacobs and Margold 2009).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Large infestations of M. spicatum *can also alter the hydrology of waterbodies and even create stagnant waters conditions (OISAP 2013).*

Environmental Impact Total	6
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Myriophyllum spicatum *populations and stagnant water also create habitat for the parasites that cause swimmer's itch and mosquitoes (Jacobs and Margold 2009, OISAP 2013).*

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR	1 √

It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U

Dense mats of M. spicatum *can reduce water flow or clog agricultural, residential, industrial, and/or power plant water intakes; removal from these structures can be expensive (IL DNR 2009, Jacobs and Margold 2009).*
Property owners, lake associations, and local governments incur costs to keep boat channels clear and the disposal of M. spicatum *(Bowen 2010).*
Waterfront property owners in Michigan spend an estimate $20 million annually to control aquatic invasive plants—primarily Eurasian watermilfoil and curly lead pondweed (Michigan Sea Grant Coastal Program 2007).
In New York, annual costs of control of Eurasian watermilfoil are estimated at $500,000 (Johnson and Blossey 2003).

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Given the reduction in recreational access and aesthetics associated with large, obstructive populations of M. spicatum, *the values of nearby property could decline (Bowen 2010, IL DNR 2009).*
According to an economic study conducted in New Hampshire, the value of property adjacent to waterbodies with large submerged aquatic plants was reduced by 15% or more (Halstead et al. 2003 in RICRMC 2007).

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6 √
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U

Even with control efforts, large infestations of M. spicatum *can severely limit recreational activities such as boating, fishing, swimming, and/or waterfowl hunting (IL DNR 2009, Jensen 2010).*
Long stems can get tangled around boat propellers and may cause damage (IL EPA 1996).
It is estimated that Eurasian watermilfoil costs Michigan millions of dollars annually in lost tourism revenue (Michigan Sea Grant 2012).

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

Large populations of Eurasian watermilfoil are often found to be aesthetically unpleasant (IL DNR 2009).

Socio-Economic Impact Total	10
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1 √
Not significantly	0
Unknown	U

Myrophyllum *spicatum is one of the few species that is capable of shading out the invasive curly pondweed, Potamogeton crispus (Aiken et al. 1979).*
Myriophyllum spicatum *is also known to inhibit the growth of cyanobacteria; which are responsible for causing harmful algal blooms (Nakai et al 2012).*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1 √
Not significantly	0
Unknown	U

If *concentrations of nitrate are high,* M. spicatum *can absorb nitrogen from the sediments or the water (Best and Mantai 1978). This ability could help improve water quality for those waterbodies affected by fertilizer runoff.* Myriophyllum spicatum *is able to uptake moderate amounts of cadmium, zinc, copper, lead, and selenium from its environment and store it in its leaves (Fawzy et al. 2012, Mechora et al. 2013). This species could be used in remediation efforts where the plants are grown in contaminated water and harvested before the leaves can break down and release the contaminants.*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Freshwater crustaceans and bass can utilize stands of M. spicatum for habitat and cover (Jacobs and Mangold 2009).
Dense mats of Eurasian watermilfoil can support the weight of frogs and wading birds (Aiken et al. 1979).
Eurasian watermilfoil can grow in adverse conditions (high nutrients/pollution or high traffic areas) that native submerged species cannot tolerate (Benson et al. 2004, GLIFWC 2006).

Beneficial Effect Total	2
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

Scientific Name: *Najas marina* L.

Common Name: spiny naiad

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Najas marina *is found throughout the Great Lakes and is considered to be a nuisance threat to the ecosystem (U.S. EPA 2008).*
In the 1940s, this species was replacing other plants species in Michigan lakes (Wentz and Stuckey 1971).
About a third of the N. marina *seeds by mallard ducks are viable after passing through the digestive track, which means a single duck can carry viable seeds 100-200 km per day (Agami and Waisel 1986).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual	1

level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	0
Total Unknowns (U)	3

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	**Unknown**
1	≥1	**Unknown**

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe	1

AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

Large infestations of Najas marina *can sometimes interfere with recreational boating and fishing (U.S. EPA 2008).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0
Unknown	U √

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1 √
Not significantly	0
Unknown	U

Mallard ducks and 18 other types of waterfowl eat the seeds of many Najas *spp. (Agami and Waisel 1986, Tarver et al. 1986).*
The seeds of N. marina *are also eaten by fish such as tilapia, grass carp and common carp (Agami and Waisel 1988).*

Beneficial Effect Total	1
Total Unknowns (U)	1

<table>
<tr><th colspan="3">Scoring</th></tr>
<tr><td>Score</td><td># U</td><td>Impact</td></tr>
<tr><td>>5</td><td>Any</td><td>High</td></tr>
<tr><td>2-5</td><td>Any</td><td>Moderate</td></tr>
<tr><td>0</td><td>0-1</td><td rowspan="2">Low</td></tr>
<tr><td>1</td><td>0</td></tr>
<tr><td>0</td><td>≥2</td><td rowspan="2"><u>Unknown</u></td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

Scientific Name: *Najas minor* All.

Common Name: brittle waternymph

Environmental: Moderate
Socio-Economic: Moderate
Beneficial: Unknown

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

Brittle waternymph starts growing early in the season, which often leads to the block the sunlight from reaching native species and inhibiting their growth (Ohio EPA 2001, Robinson 2004).
This species can also out-compete nearby plants for space (Office of Water Resources 2010).
Najas minor *grows aggressively in shallow waters and has formed dense, monospecific stands in the shallow waters of Lake Erie (Reznicek et al. 2011, U.S. EPA 2008).*
Najas minor *can also form dense underwater meshes with other exotic species such as Hydrilla verticillata (Kay and Hoyle 1999).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

These dense plant communities can produce unfavorable conditions for to fish and waterfowl (Kay and Hoyle 1999, Office of Water Resources 2010).
Animals may also be driven out of N. minor *dominate ecosystems if they are dependent on the displaced native vegetation for survival (Robinson 2004).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

As dense mats of brittle waternymph die and decompose, the amount of oxygen in nearby water and sediment maybe be significantly decreased (Robinson 2004). In extreme cases, anoxic conditions can lead to fish kills (Robinson 2004).

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Although, this species typically invades shallow water, in North Carolina dense shoals of N. minor *have grown in waters up to 4 meters deep (Kay and Hoyle 1999).*
Dense populations of brittle waternymph have increased sedimentation rates and clogged waterways in Massachusetts (Robinson 2004).

Environmental Impact Total	3
Total Unknowns (U)	1

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low

1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Najas minor *populations can reduce the discharge capacity (quantity of water) of channels (WI DNR 2010).*

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

Dense stands of N. minor *can hinder recreational activities such as, boating, fishing, and/or swimming (Office of Water Resources 2010, U.S. EPA 2008, WI DNR 2010).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

Along with reduced recreational ability, populations of brittle waternymph can also diminish the aesthetic value of the surrounding areas (WI DNR 2010).
Limited recreational use and a decline in aesthetic value associated with large N. minor *infestations can lead to reduced property values around the effected waterbody (Robinson 2004).*

Socio-Economic Impact Total	2
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0
Unknown	U √

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0
Unknown	U √

Najas minor *is tolerant of adverse growing conditions including increased turbidity, eutrophic ecosystems, and some pollution (Wentz and Stuckey 1971, WI DNR 2010).*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1 √
Not significantly	0
Unknown	U

Mallard ducks and 18 other types of waterfowl eat the seeds of many Najas *spp. (Agami and Waisel 1986, Tarver et al. 1986).*

Beneficial Effect Total	1
Total Unknowns (U)	2

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**<u>Unknown</u>**
1	≥1	

Scientific Name: *Nasturtium officinale* W.T. Aiton

Common Name: Watercress

Environmental: Unknown
Socio-Economic: Low
Beneficial: Moderate

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Newman et al. (1992) found that watercress produces a chemical defense that deters generalist feeders such as the amphipod Gammarus pseudolimnaeus, the caddisflies Hesperophylax designates *and* Limnephilus *spp., and the physid snail* Physella *spp. (Newman et al. 1992).*
Nasturtium officinale *can host the* Spongospora subterranea *(crook root fungus) and yellow spot virus (Walsh and Phelps 1991).*
Cabbage black-ringspot versus and the cucumber mosaic virus has been found on cultivated populations of Nasturtium officinale *(Howard and Lyon 1952).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Water *cress is able to take up large amounts of nitrate from water bodies it lives in (Howard-Williams et al. 1982).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Nasturtium officinale *can hybridize with* N. microphyllum *Boenn. ex Rchb, another invasive found in the Great Lakes, to produce the hybrid* N. X sterile *(Airy Shaw) Oefelein (Bleeker et al. 1999).*
However, this hybrid only produces viable seeds when the female parent is N. mircophyllum *(Howard and Lyon 1952).*
The sterile hybrid can still propagate and expand vegetatively (Reznicek et al. 2011).
Observations of this hybrid species in Germany found that N. x sterile *is more rigorous and is quicker at establishing itself from cuttings than either parent species (Bleeker et al. 1999).*
Nasturtium X sterile *individuals have been found in Wisconsin Robert W. Freckman Herbarium 2012).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Watercress if able to uptake large amounts of nitrate from water bodies it lives in (Howard-Williams et al. 1982). The nitrogen is released when the plants die and decompose; however, if the plants are removed (as is the goal with most invasive species) this could alter the amount of nitrogen available (Howard-Williams et al. 1982).

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Watercress can grow into large mats in slow parts of streams, typically in the bends and curves of the steam's path. If populations get big enough, they could contribute significantly to the meanders of the stream (Kullberg 1974). However, Benson et al. (2004) found that this species causes minimal impact on natural communities in the Northwest region of the United States (Benson et al. 2004).

Environmental Impact Total	1
Total Unknowns (U)	3

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Watercress can also host Fasciola hepatica*, common live fluke (CDC 2013). People can become infected by eating raw watercress contaminated with fluke larvae (CDC 2013).*

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Nasturtium officinale *can host the crook root fungus, yellow spot virus, cabbage black-ringspot virsus, and the cucumber mosaic virus (Howard and Lyon 1952, Walsh and Phelps 1991). If watercress is growing near cultivated lands, these viruses could infect and damage crops.*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Nasturtium officinale *can be eaten raw, has high concentrations of vitamins and minerals, and has a peppery flavor (Benson et al. 2004, Robert W. Freckman Herbarium 2012, State of Washington 2013).*

This species is harvested recreationally and grown commercially in the United States (CANSWP 2006, State of Washington 2013).
People can become infected by eating raw watercress contaminated with fluke larvae (CDC 2013).

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1 √
Not significantly	0
Unknown	U

Nasturtium officinale *can be eaten raw, has high concentrations of vitamins and minerals, and has a peppery flavor (Benson et al. 2004, Robert W. Freckman Herbarium 2012, State of Washington 2013).*
This species is harvested recreationally and grown commercially in the United States (CANSWP 2006, State of Washington 2013).
People can become infected by eating raw watercress contaminated with fluke larvae (CDC 2013).

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

Watercress has been used an herbal remedy for a variety of ailments: common cold; sore throat; earache; improve heart, kidney, and respiration health; the juice has been used to heal skin sores and acne (Robert W. Freckman Herbarium 2012).
Nasturtium officinale *has potent anti-oxidative properties and may have applications in the prevention of free radical-related diseases (Bahramikia and Yazdanparast 2010).*
Gill et al. (2007) found that consumption of watercress may lead to decreased damage to DNA and increased carotenoid concentrations; ultimately reducing the risk of cancer.

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1 √
Not significantly	0
Unknown	U

In test sites monitored by Redding et al. (1997), N. officinale *was able to significantly reduce the concentrations of ammonia-N, nitrate-N and phosphorus in the wastewater. Effective treatment was dependent on harvesting the plant biomass (Redding et al. 1997).*
Nasturtium officinale *is able to withstand the stress and accumulate moderate amounts of arsenic, nickel, and lead (Duman and Ozturk 2010, Keser and Saygideger 2010, Ozturk et al. 2010).*
A year after the closure of a paper mill on a stream in Michigan, this species was one of a few found growing downstream of the polluted site (Kullberg 1974).
This ability to uptake nutrients and contaminants make N. officinale *a possible candidate for use in phytoremediation or wastewater treatment operations.*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

In Washington, watercress was reportedly eaten by ducks, muskrats, and deer (Robert W. Freckman Herbarium 2012).
Newman et al. (1992) found that watercress produces a chemical defense that deters generalist feeders such as the amphipod Gammarus pseudolimnaeus*, the caddisflies* Hesperophylax designates *and* Limnephilus *spp., and the physid snail* Physella *spp. (Newman et al. 1992).*

Beneficial Effect Total	3
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Nymphoides peltata* (S.G. Gmel.) Kuntze

Common Name: yellow floating heart

Environmental: Moderate
Socio-Economic: Low
Beneficial: Moderate

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

These areas of stagnant waters (created by N. peltata*) can be an ideal location for mosquitos to breed (OISAP 2013).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

Nymphoides peltata *can form dense floating mats of vegetation that block sunlight from reaching native plants and algae (IL DNR 2005, Lui et al. 2010, OISAP 2013).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1 √
Not significantly	0
Unknown	U

Depending on the extent of the yellow floating heart population, the algae population could decline and disrupt the food web (Kelly and Maguire 2009).
The reduction in native plant species degrades the habitat and may reduce access to food for fish and wildlife (IL DNR 2005, OISAP 2013)
If the population of yellow floating heart is large enough, fish and other wildlife may be forced to relocate (CEH 2004).

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Dense stands of N. peltata *can cause slow-moving water to become stagnant and the water beneath the mats to have a low oxygen concentration (DiTomaso and Healey 2003, IL DNR 2005, Lui et al. 2010, WI DNR 2012).*
Dense surface mats of N. peltata *can hinder the air exchange between the water's surface and the atmosphere (Kelly and Maguire 2009).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Dense stands of N. peltata *can cause slow-moving water to become stagnant… (DiTomaso and Healey 2003, IL DNR 2005, Lui et al. 2010, WI DNR 2012).*
In large populations of yellow floating heart, sedimentation levels increase and could alter nearby hydrology (Kelly and Maguire 2009).
In New England, dense stands of N. peltata *have blocked waterways (IPANE 2013).*

Environmental Impact Total	4
Total Unknowns (U)	1

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**

0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

These areas of stagnant waters (created by N. peltata*) can be an ideal location for mosquitos to breed (OISAP 2013).*

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

The reduction in aesthetic and recreational value can lead to a decline in nearby waterfront property (Kelly and Maguire 2009).

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

In locations outside the Great Lakes, dense mats of yellow floating heart have interfered with or even prevented recreational boating, canoeing, angling, water skiing, and swimming (CEH 2004, Lui et al. 2010, WI DNR 2012).

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

The reduction in aesthetic and recreational value can lead to a decline in nearby waterfront property (Kelly and Maguire 2009).

Socio-Economic Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Nymphoides peltata *is a popular ornamental plant for outdoor water gardens and is easily purchased via the internet or by mail-order (Benson et al. 2004, IL DNR 2005, OISAP 2013).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or	6

tourism	
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1√
Not significantly	0
Unknown	U

Nymphoides peltata *has the ability to move nitrogen and phosphorus up from the sediment into the aboveground biomass and back down into the root structure during the winter. This ability regenerates the nitrogen and phosphorus levels in the sediment (Brock et al. 1983).*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	2
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Pluchea odorata var. odorata* (L.) Cass.

Common Name: marsh fleabane

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Pluchea odorata *is capable of hybridizing with* P. indica *to produce* Pluchea X fosbergii (*Cooperrider and Galang 1965).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	1
Total Unknowns (U)	5

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √

Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High

2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

The leaves and stems of P. odorata *have been used medicinally in Africa and India (King-Jones 2001). Extracts of* P. odorata *have been shown to heal wounds, reduce inflammation, and inhibit the growth of cancer cells (Gridling et al. 2009, Seelinger et al. 2012).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	1
Total Unknowns (U)	0

<table>
<tr><td colspan="3">Scoring</td></tr>
<tr><td>Score</td><td># U</td><td>Impact</td></tr>
<tr><td>>5</td><td>Any</td><td>High</td></tr>
<tr><td>2-5</td><td>Any</td><td>Moderate</td></tr>
<tr><td>0</td><td>0-1</td><td rowspan="2"><u>Low</u></td></tr>
<tr><td>1</td><td>0</td></tr>
<tr><td>0</td><td>≥2</td><td rowspan="2">Unknown</td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

Scientific Name: *Pluchea odorata* var. *succulent (*Fernald) Cronquist

Common Name: sweetscent

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Pluchea odorata var. succulenta *has invaded high marsh ecosystems in New York (Lamont and Stalter 1991).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0

Unknown	U

Pluchea odorata *is capable of hybridizing with* P. indica *to produce* Pluchea X fosbergii *(Cooperrider and Galang 1965).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	1
Total Unknowns (U)	4

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	**Unknown**
1	≥1	**Unknown**

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1

Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact

>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

The leaves and stems of P. odorata *have been used medicinally in Africa and India (King-Jones 2001). Extracts of* P. odorata *have been shown to heal wounds, reduce inflammation, and inhibit the growth of cancer cells (Gridling et al. 2009, Seelinger et al. 2012).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Poa trivialis*

Common Name: rough-stalked meadow grass

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	1

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Considered a nuisance species in turfgrass (e.g.,fairways, sports fields).

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**

1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1 √
Not significantly	0
Unknown	U

Widely planted as a pasture grass. It is used for forage hay and pasturage in marshlands.

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6

Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Polygonum persicaria*

Common Name: Lady's thumb, smartweed, spotted knapweed

Environmental: Unknown
Socio-Economic: High
Beneficial: Moderate

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

P. persicaria *competes with natural vegetation, particularly in moist areas along ditches, streams, rivers, and marshes.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1

Not significantly	0
Unknown	U √

Several Polygonum *species are native to the Great Lakes region, but information on potential hybridization is not readily available.*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Stands can slow water flow in canals and streams (DiTomaso and Healy 2003)

Environmental Impact Total	1
Total Unknowns (U)	2

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	**Unknown**
1	≥1	**Unknown**

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe	1

AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Common name 'smart weed' reflects that this plant contains a chemical compound which causes a burning sensation and mild irritation.

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6 √
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

The economic impact of P. persicaria *in agricultural production is sufficient for various governments to declare this weed as a noxious pest (Anon., 1996; Anon., 2003). The state of Minnesota in the USA has declared* P. persicaria *as a secondary noxious weed and several states have categorized it as invasive (USDA-NRCS, 2002).*
P. persicaria *can be very competitive with crop plants, particularly in moist soils and as such can have significant economic impacts in the requirements for use of increased tillage and herbicides, though exact data on costs due to the presence of this species are not known. Holm et al. (1997) note that it is a weed of 35 crops in 50 countries.*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6

Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	6
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

leaves and young shoots may be eaten, but not grown commercially for this purpose.

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

Contains persicarin. *persicarin should be viewed as a candidate therapeutic for the treatment of severe vascular inflammatory diseases, such as, sepsis or septic shock. (Kim et al 2013).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1 √
Not significantly	0
Unknown	U

Has been demonstrated to removed >60% of nitrite from ground and surface water, however other aquatic macrophytes are available which are even more efficient at nitrite remediation (Rawat et al 2012).

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Seeds are important food sources for many birds and mammals (DiTomaso and Healy 2003).

Beneficial Effect Total	2
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

Scientific Name: *Potamogeton crispus* L.

Common Name: curlyleaf pondweed

Environmental: Moderate
Socio-Economic: Moderate
Beneficial: Moderate

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

Potamogeton crispus *is tolerant of many ecological conditions (low/high nutrients, slow/fast water flow, low/high temperatures, low/high light) and can invade numerous aquatic ecosystems (CEH 2004, Group 2006, Guard 1995). Curlyleaf pondweed germinates in the fall and survives the winter (IPANE 2013). This growth habit, along with tolerance of low light and low water temperatures, allows curlyleaf pondweed to begin growing in the spring before native plant species (IPANE 2013, WIDNR 2012).*
Potamogeton crispus *can outcompete native species for light and space early in the growing season; often reducing plant diversity by forming monocultures (ENSR International 2005, PA DCNR n.d., WI DNR 2012).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1 √
Not significantly	0
Unknown	*U*

Dense stands of curlyleaf pondweed can alter the predator/prey relationship and affect the overall ecology of an aquatic ecosystem (ENSR International 2005).

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Potamogeton xcooperia is a hybrid between P. crispus and P. perfoliatus, which is also found in the Great Lakes., has been found in Europe (Kaplan and Fehrer 2004).

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

When dense stands of curlyleaf pondweed die off midsummer, it can have a drastic effect on the water quality. A large amount of phosphorus is released into the water which can lead to eutrophic waters and possible algal blooms (Benson et al. 2004, PA DCNR n.d., WI DNR 2012).
As the vast quantity of plant matter decomposes, the concentration of oxygen in the water can drop significantly and possibly impact fish (IPANE 2013, Lui et al. 2010).

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	*U*

Large infestations of P. crispus *can impede water flow and cause stagnant water conditions (Catling and Dobson 1985 in ENSR International 2005, Lui et al. 2010).*

Environmental Impact Total	5
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**

0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Waterfront property owners in Michigan spend an estimated $20 million annually to control aquatic invasive plants—primarily Eurasian watermilfoil and curlyleaf pondweed (MSGCP 2007).

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Decomposing mats of curlyleaf pondweed release phosphorus; which can cause an increase in algal blooms and effect drinking water quality (WI DNR 2012).

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Dense growth of P. crispus *can reduce the flow in irrigation canals (Catling and Dobson 1985 in ENSR International 2005).*

Expensive control programs are often needed to reduce the impacts on recreational activities and to maintain waterfront property values (IL DNR 2005).

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

Surface mats of P. crispus *can become a nuisance and inhibit aquatic recreation such as boating, fishing, and swimming (ILDNR 2009, Jensen 2009, PA DCNR n.d.).*
Dense colonies of curlyleaf pondweed can restrict access to docks and fishing areas until July, when the plants dieback (Jensen 2009).

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

Dead mats of P. crispus *can pile up along the shoreline; greatly reducing the aesthetic value of waterfront property (WI DNR 2012).*

Socio-Economic Impact Total	4
Total Unknowns (U)	1

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**<u>Moderate</u>**
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

<u>BENEFICIAL EFFECT</u>

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1

Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

Aqueous extracts of P. *crispus demonstrated antimicrobial activity against 17 different microorganisms including* Escherichia coli *and* Staphylococcus aureus *(Fareed et al. 2008).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1 √
Not significantly	0
Unknown	U

Potamogeton *crispus is able to remove dibutyl phthalate and phthalic acid esters when grown experimentally in contaminated water (Chi and Cai 2012, Chi and Yang 2012).*
Experiments conducted in China showed that P. crispus *is able of removing nitrogen from eutrophic water and sediment; thus improving the water quality (Ren et al. 2011).*
Curlyleaf pondweed is able to uptake cerium, cobalt, cesium, and their isotopes; indicating that it could be used to treat low level liquid radioactive waste (Hafez et al. 1992).
This species is also able to remove cadmium from water, but at the cost of decreased photosynthesis (Sivaci et al. 2008).
Populations of P. crispus *have no effect on dissolved oxygen concentrations, slightly increase the pH and reduce the total dissolved solids and the nitrogen concentration; leading to an overall improvement in water quality (Wang et al. 2011).*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1 √
Not significantly	0
Unknown	U

Curlyleaf pondweed provides habitat for aquatic life when native plants are not present in the winter and early spring (IL DNR 2005).
Populations provide habitat for macroinvertbrates, which are food sources for fish and waterfowl on their northern migration (Catling and Dobson 1985 in ENSR International 2005, GLC 2006).

Beds of P. crispus *also provide spawning substrate and habitat for game fish (GLC 2006, Lembi 2003).*

Beneficial Effect Total	3
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	<u>**Moderate**</u>
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Puccinellia distans*

Common Name: reflexed salt grass

Environmental: Low
Socio-Economic: Low
Beneficial: Moderate

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Appears to outcompete native grasses only in areas of salt contamination.
Puccinellia *seedlings are described as having low competitive ability (Virtue and Melland 2003) and this is supported by Barrett-Lennard and Moore (2003) who report that in sown situations seedlings compete poorly with annual weeds. However,* Puccinellia *may readily establish in suitable habitats where there is limited competition from native vegetation or in areas of bare ground (such as salt marsh, lake edges or estuaries) (Virtue and Melland 2003). It may cause some displacement of other plant species but is unlikely to become dominant.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual	1

level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

It may slow water flow in previously open areas, but the effect is not likely significant. It is not believed to effect nutrient levels.

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Given its habitat preference it is possible that it may have some silting effect in certain ecosystems, but this is undocumented.

Environmental Impact Total	0
Total Unknowns (U)	1

<table>
<tr><th colspan="3">Scoring</th></tr>
<tr><td>Score</td><td># U</td><td>Impact</td></tr>
<tr><td>>5</td><td>Any</td><td>High</td></tr>
<tr><td>2-5</td><td>Any</td><td>Moderate</td></tr>
<tr><td>0</td><td>0-1</td><td rowspan="2"><u>Low</u></td></tr>
<tr><td>1</td><td>0</td></tr>
<tr><td>0</td><td>≥2</td><td rowspan="2">Unknown</td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1

Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1 √
Not significantly	0
Unknown	U

Puccinellia *distans (Weeping Alkali-Grass) is apparently of no economic importance in the U.S. (Hitchcock and Chase 1950).*
Cultivars are sometimes used for fairways (roughs) and occasionally as a turfgrass in areas where salt contamination prevents other species from thriving (e.g., roadside trails).

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1 √
Not significantly	0
Unknown	U

Research indicates that Puccinellia distans *increases the microbial population significantly and may be of use in hydrocarbon degradation for phytoremediation (Ezzatian et al 2009)*
It can be used as a pioneer plant for the reclamation of badly salt affected and/or eroded sites.

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	2
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

Scientific Name: *Rorippa sylvestris*

Common Name: creeping yellow cress

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Allelopathic, inhibiting germination of seeds of many other plants (Yamane et al 1992).

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Described as a pioneer species, it does not generally outcompete dense, established natives.

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1

Not significantly	0
Unknown	U √

R. sylvetris is *known to hybridize with other members of the genus, but the degree to which it will hybridize with* Rorippa *spp. native to the Great Lakes region (e.g.,* Rcurvipes, R. palustris, R. sessiliflora, R. sinuate) *is unknown.*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	1
Total Unknowns (U)	3

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	**Unknown**
1	≥1	**Unknown**

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR	1

It has significantly affected human health in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Designated as a noxious weed. Considered a serious pest to horticulture (ornamentals) and potential threat to crop and grazing lands. can reduce bulb crop value and marketability as a contaminate of nursery stock

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

<table>
<tr><td colspan="3">Scoring</td></tr>
<tr><td>Score</td><td># U</td><td>Impact</td></tr>
<tr><td>>5</td><td>Any</td><td>High</td></tr>
<tr><td>2-5</td><td>Any</td><td>Moderate</td></tr>
<tr><td>0</td><td>0-1</td><td rowspan="2"><u>Low</u></td></tr>
<tr><td>1</td><td>0</td></tr>
<tr><td>0</td><td>≥2</td><td rowspan="2">Unknown</td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

Scientific Name: *Rumex longifolius*

Common Name: Yard dock

Environmental: unknown
Socio-Economic: unknown
Beneficial: low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

The seeds and vegetation of docks can be toxic to animals (Royer and Dickinson 1999).
Dock species are also an alternate host for number of viruses, fungus, and nematodes (Edwards and Taylor 1963).Pplants can host high diversity of plant pathogens and invertebrate pests that may affect surrounding plants (Martinkova et al., 2009 and references therein).

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

It is an invasive species which can compete with native species. It likely pushes out native species once established.

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual	1

level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U √

The species hybridizes frequently

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	1
Total Unknowns (U)	2

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	**Unknown**
1	≥1	**Unknown**

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6

Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Dock is occasionally eaten – in high quantities, the oxalic acid it contains can be a health risk.

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

These docks are undesirable in grasslands because they decrease yields and reduce forage feeding value. As a weed of pastures and meadows, the main impact of this plant is to reduce the value of infested land as grazing for livestock. R. obtusifolius is only 65% as valuable as grass as grazing material because of a combination of reduced palatability (and therefore grazing levels) and reduced digestibility (Courtney & Johnson, 1978 in Grossrieder & Keary, 2004). It also contains oxalic acid which may be poisonous to livestock. Mature plants also suppress the grass yield of pasture. Oswald and Haggar (in Grossrieder & Keary, 2004) found that increasing ground cover by Rumex *reduced grass yields, as did increasing* Rumex *density.*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6

Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	1
Total Unknowns (U)	1

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	**Unknown**
1	≥1	**Unknown**

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

Scientific Name: *Rumex obtusifolius*

Common Name: Bitter dock

Environmental: Unknown
Socio-Economic: Unknown
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Dock species are also an alternate host for number of viruses, fungus (Dal Bello and Carranza 1995), and nematodes (Edwards and Taylor 1963, Townshend and Davidson 1962).
The seeds and vegetation of docks can be toxic to animals (Royer and Dickinson 1999).
Plants can host high diversity of plant pathogens and invertebrate pests that may affect surrounding plants (Martinkova et al., 2009 and references therein).

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

It is an invasive species which can compete with native species. It likely pushes out native species once established

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6

Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Dock species frequently hybridize.

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	1
Total Unknowns (U)	2

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	**Unknown**
1	≥1	**Unknown**

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6

Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

These docks are undesirable in grasslands because they decrease yields and reduce forage feeding value. As a weed of pastures and meadows, the main impact of this plant is to reduce the value of infested land as grazing for livestock. R. obtusifolius *is only 65% as valuable as grass as grazing material because of a combination of reduced palatability (and therefore grazing levels) and reduced digestibility (Courtney & Johnson, 1978 in Grossrieder & Keary, 2004). It also contains oxalic acid which may be poisonous to livestock. Mature plants also suppress the grass yield of pasture. Oswald and Haggar (in Grossrieder & Keary, 2004) found that increasing ground cover by Rumex reduced grass yields, as did increasing* Rumex *density.*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6

Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	1
Total Unknowns (U)	1

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	**Unknown**
1	≥1	**Unknown**

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Bitter dock is avoided by rabbits, but it appeared to be a favorite food plant of deer (Amphlett and Rea 1909, cited in Cavers and Harper 1964).

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Salix alba*

Common Name: White willow

Environmental: Unknown
Socio-Economic: Low
Beneficial: High

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Salix alba *is susceptible to many diseases and parasites. The degree to which it may serve as a vector of disease into to related species is unknown.*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1

Not significantly	0
Unknown	U √

Salix alba *will hybridize with other willows. The degree to which this effects native willows is unknown*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	0
Total Unknowns (U)	6

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1

Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact

>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1 √
Not significantly	0
Unknown	U

White willow is cultivated as a source of salicyclic acid (a component of aspirin), for willow bark (natural medicine), for its soft elastic wood (commonly used in basketmaking and other crafts), for fiber (papermaking) and other purposes.

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1 √
Not significantly	0
Unknown	U

Commonly used as a landscape plant, but native alternatives are available.

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6 √
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0
Unknown	U

The original source of salicyclic acid (aspirin), still a common component of natural medicines.

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √

Unknown	U

This species has been investigated for potential use in pytoremediation of iron cyanide (Yu et al 2006).

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1 √
Not significantly	0
Unknown	U

Provides riparian habitat for many species of birds and insects. Along with native willows, can be an important food source for many species of caterpillars.

Beneficial Effect Total	9
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	**<u>High</u>**
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

Scientific Name: *Salix fragilis*

Common Name: Crack willow

Environmental: Unknown
Socio-Economic: Moderate
Beneficial: Moderate

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Crack willow is susceptible to a variety of parasites and diseases. The degree to which it may serve as a vector for these into native willows is not known.

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

There are negative consequences for biodiversity where S. fragilis becomes invasive since the thick canopy created when it is dominant is sufficient to shade out other plants and reduce invertebrate abundance (Weber, 2003). These changes may also affect fish (Anon, 2000). Flora and fauna associated with both the banks and aquatic environment may be affected.

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Some research shows that increased shade cover may impact benthic macroinvertebrate communities, but whether this effect is specific to crack willow (as opposed to other riparian trees) is not known.

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Salix fragilis *will hybridize with other willows, but the degree to which this has affected native willows is unknown.*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Willow debris can block streams during floods and damage bridges and roads (Anon., 2000). Where large infestations have established the costs of removal and restoration may be high.
Environmental damage from S. fragilis *invasion includes changes to stream hydrology, higher erosion and sedimentation rates and flooding patterns, and they may also use more water than indigenous plant species and cause changes to nutrient cycling, water temperature, energy fluxes and general water quality may also result (Anon., 2000).*

Environmental Impact Total	1
Total Unknowns (U)	5

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	**Unknown**

1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Crack willows are relatively fragile and storm-damaged trees can cause damage to adjacent infrastructure.

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

Willows such as S. fragilis *may impede recreational activities such as canoeing and fishing (Anon., 2000).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	2
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

S. fragilis *is considered an important species in hedgerows, shelterbelts and windbreaks, along fields and field channels. It has also been planted to prevent soil erosion along streambanks.* S. fragilis *is not a timber species (wood density is about 450 kg/m³ at 15% moisture content) and has been mainly used for fuelwood*. S. fragilis *was once an important species for basket-making industries. (CABI 2014).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6

It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1 √
Not significantly	0
Unknown	U

Salix fragilis *has been investigated for suitability for phytoremediation of metals. It may be suitable for remediation of sites contaminated with cadmium and zinc (Vandesasteele et al 2005). It has also been investigated and has potential for phytoremediation of sulfonamide anitibiotics (from confined feedlot livestock operations) (Michelini et al 2012).*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1 √
Not significantly	0
Unknown	U

Has been used for bank stabilization, riparian habitat, etc.

Beneficial Effect Total	2
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**<u>Moderate</u>**
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

Scientific Name: *Salix purpurea*

Common Name: purple willow, purple osier willow

Environmental: Unknown
Socio-Economic: Low
Beneficial: Moderate

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Susceptible to many diseases and parasites, but the extent to which it forms a vector for these into native willows is unknown.

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

"The crack willows have the ability to produce dense stands in floodplains and other favorable habitats. Because most native willows are much smaller in stature than the crack willows, and because most willows are not very shade-tolerant, is seems likely that crack willows would tend to overtop and displace native willows." http://invasives.glifwc.org/Salix_spp/eco_impacts.html.

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6

Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

This species will likely hybridize with other willows, but the degree to which this effects native willows is unknown.

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Stabilizes streambanks and prevents erosion.

Environmental Impact Total	0
Total Unknowns (U)	5

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	**Unknown**
1	≥1	**Unknown**

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0

Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1 √
Not significantly	0
Unknown	U

Used to control erosion along streambanks.
Used for basket-making.

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6

Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1 √
Not significantly	0
Unknown	U

Provide cover for small animals and browse for deer, beaver and rabbits as well as exceptional nesting sites for birds.

Beneficial Effect Total	2
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**<u>Moderate</u>**
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

Scientific Name: *Solanum dulcamara* L.

Common Name: bittersweet nightshade

Environmental: Moderate
Socio-Economic: Moderate
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Solanum dulcamara, *along with other plants in the nightshade family, is poisonous. It produces solanine in its leaves, shoots, and unripe berries. If ingested by animals, it can cause difficult breathing, weakness, dermatitis, gastrointestinal irritation/pain, nervous system problems, and in severe cases death (Forest Health Staff 2006, King County 2010).*
Bittersweet nightshade also has a strong, unpleasant odor so most animals will avoid it and poisonings from this plant are not very frequent.
Water extract from the leaves of S. sulcamara *significantly inhibited the growth of Pinus resinosa seedlings; however, this allelopathy has not been studied in the field (Waggy 2009).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

The vines of S. dulcamara *can grow over nearby trees and shrubs, and even pull down smaller plants (Forest Health Staff 2006, IPANE 2013).This growing ability can quickly lead to dense thickets of bittersweet nightshade (King County 2010).*
Bittersweet nightshade is abundant throughout Michigan and Ohio (OARDC Extension 2013, Reznicek et al. 2011). The New York Invasive Species Council ranks this species moderate ecological risk (New York Invasive 2010).
Falck and Garske (2002) acknowledge that given this species small size and ability to thrive in forested areas, that data about its presence is likely underrepresented.

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species	1

population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

In studies conducted in New Zealand, species within the Solanum *genus showed resistance to hybridization (Armstrong et al. 2005). This indicates that* S. dulcamara *may pose only a small genetic threat to native or crop species.*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Solanum dulcamara *can also become dominant along small waterways and alter the flow of water (King country 2010).*

Environmental Impact Total	2
Total Unknowns (U)	2

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

All portions of this plant are poisonous (Forest Health Staff 2006).
It has been reported that paralysis can occur in humans after consuming only 6 berries (OARDC Extension 2006).

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Poisoning from S. dulcamara *has been reported in cattle, sheep, and horses (OARDC Extension 2006).*

Bittersweet nightshade can act as a host for Leptinotarsa decemlineata *(Colorado potato beetle). This beetle can invade species from the* Solanaceae *family, such as potatoes and tomatoes, and could damage the crops (IPANE 2013, OARDC Extension 2006).*
However, success of beetles reared on S. dulcamara *varied depending on seasonally varying phytochemicals present in the plant (Hare 1983).*
Solanum dulcamara *can also host two other pathogens:* Phytophthora infestans *(causes potato blight) and* Ralstonia solanacearum *(causes brown rot in potatoes) (Golas et al. 2010, Knapp 2013).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	2
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	**<u>Moderate</u>**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

<u>BENEFICIAL EFFECT</u>

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √

Unknown	U

Solanum dulcamara *contain glycosides; which can be used in the production of steroidal hormones (Curtis et al. 2000).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

Extracts from the roots, bark, and stems of S. dulcamara *have been used to relieve pain caused by rheumatism, poor circulation, ulcers, and skin afflictions. Currently, these extracts are not widely used (Waggy 2009).*
Alcoholic extracts of S. dulcamara*, taken from plants grown in New York and Wisconsin, exhibited tumor-inhibitory activity in mice (Kupchan et al. 1965).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U's	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	

0	≥2	Unknown
1	≥1	

Scientific Name: *Solidago sempervirens*

Common Name: seaside goldenrod

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

It has been reported that the release of root exudates by seaside goldenrod produce allelochemicals that negatively affect the growth of nearby vegetation. Studies By Cheplick and Aliotta (2009) have found that seaside goldenrod has a negative effect on the growth of native grasses.

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Growing in areas that collect salt runoff they compete with few native plants in this harsh environment.

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level	1

AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	1
Total Unknowns (U)	4

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	**Unknown**
1	≥1	**Unknown**

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR	1

It has significantly affected human health in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

In areas where it is native, this plant has been used for dune stabilization and erosion control.
Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact

>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

<table>
<tr><td colspan="3">Scoring</td></tr>
<tr><td>Score</td><td># U</td><td>Impact</td></tr>
<tr><td>>5</td><td>Any</td><td>High</td></tr>
<tr><td>2-5</td><td>Any</td><td>Moderate</td></tr>
<tr><td>0</td><td>0-1</td><td rowspan="2"><u>Low</u></td></tr>
<tr><td>1</td><td>0</td></tr>
<tr><td>0</td><td>≥2</td><td rowspan="2">Unknown</td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

Scientific Name: *Sparganium glomeratum*

Common Name: bur reed

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Many hybrids are reported in Sparganium *but few are verified.*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Environmental Impact Total	0
Total Unknowns (U)	6

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	**Unknown**
1	≥1	**Unknown**

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1

Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or	6

native species	
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

Beneficial Effect Total	0
Total Unknowns (U)	1

<table>
<tr><th colspan="3">Scoring</th></tr>
<tr><td>Score</td><td># U</td><td>Impact</td></tr>
<tr><td>>5</td><td>Any</td><td>High</td></tr>
<tr><td>2-5</td><td>Any</td><td>Moderate</td></tr>
<tr><td>0</td><td>0-1</td><td rowspan="2"><u>Low</u></td></tr>
<tr><td>1</td><td>0</td></tr>
<tr><td>0</td><td>≥2</td><td rowspan="2">Unknown</td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

Scientific Name: *Trapa natans* L.

Common Name: Water chestnut

Environmental: High
Socio-Economic: High
Beneficial: Moderate

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Water chestnut is also capable of an allelopathic response that inhibits the growth of phytoplankton (Lui et al. 2010a).
Areas of stagnant water caused by dense stands of T. natans create breeding grounds for mosquitoes (Naylor 2003).

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

Trapa natans *is a fast-growing species that forms mats of vegetation that float on the water's surface (IPANE 2013, Swearingen et al. 2002).*
Given its biological structure, T. natans *is able to cover the water with up to three layers of leaves (Pemberton 2002).*
These dense mats inhibit the growth of native aquatic species and enable water chestnut to outcompete for sunlight, nutrients, and space (IN DNR 2012, OISAP 2013, Pennsylvania Sea Grant 2012).
Water chestnut is able to prevent sunlight from reaching the bottom sediments; making it especially threatening to native grasses (Naylor 2003).
The introduction of T. natans *leads to a reduction in plant biodiversity as it comes to dominate aquatic ecosystems (OISAP 2013, Pennsylvania Sea Grant 2012).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1 √

Not significantly	0
Unknown	U

Trapa natans *offers little nutritional value for wildlife (IPANE 2013, Pennsylvania Sea Grant 2012, VDEC 2002). Water chestnut is also capable of an allelopathic response that inhibits the growth of phytoplankton (Lui et al. 2010a).*
These two impacts may alter existing predator/prey relationships as native species go elsewhere to search for food.

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

During the growing season, dense surface mats block the air exchange between the water's surface and the atmosphere (Pennsylvania Sea Grant 2012).
Caraco and Cole (2002) found that beds dominated by T. natans *had dissolved oxygen levels below 2.5 mg/l about 40% of the time. Low levels of oxygen caused by the presence of this species, makes* T. natans *populations unsuitable for fish species and likely effects the redox reactions in bottom sediments (Caraco and Cole 2002). When water chestnut populations die and sink, the decomposition of this large amount a plant material reduces the dissolved oxygen level even further and in extreme cases, can cause fish kills (IN DNR 2012, OISAP 2013, Swearingen et al. 2002, VDEC 2002).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Large infestations of T. natans *can reduce water flow and even clog waterways (CANSWG 2006, Naylor 2003, Pennsylvania Sea Grant 2012).*

Environmental Impact Total	5
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Areas of stagnant water caused by dense stands of T. natans *create breeding grounds for mosquitoes (Naylor 2003).*

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Large infestations of T. natans *can reduce water flow and even clog waterways (Group 2006, Naylor 2003, Pennsylvania Sea Grant 2012).*

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6 √
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR	1

It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U

Dense patches of T. natans *can hinder commercial navigation (IN DNR 2012, IPANE 2013).*
The major economic costs associated with water chestnut populations are mechanical or chemical control efforts (Naylor 2003).
The Pennsylvania Department of Conservation and Natural Resources (n.d.) states that this species costs hundreds of thousands of dollars to control.
Millions of dollars have been spent on mechanical harvesting and manual removal of T. natans *populations; these programs have had limited success (Wu and Wu 2006). Vermont spent almost $500,000 in 2000 to mechanically remove water chestnut (Pennsylvania Sea Grant 2012).*
From 1982-2005 various state organizations spent over $5 million to control T. natans *in Lake Champlain (IPANE 2013).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

Infestations of water chestnut can also limit or even prevent recreational activities such as boating, fishing, and hunting (WI DNR 2012).
These nuts can also wash up and accumulate along the shore; reducing the access to beaches (IN DNR 2012, OISAP 2013).
In Vermont, many previously fished bays of southern Lake Champlain are now inaccessible, and floating mats of T. natan*s can create a hazard for boaters. Large stands of water chestnut may also restrict fish farming and batfish harvesting (Gunderson and Kinnunen 2004).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

The hard, spiny seeds can punctuate leather and can cause painful wounds to humans and animals that step on them (Haber 1999, Swearingen et al. 2012).

Socio-Economic Impact Total	8
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	**<u>High</u>**
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

This ornamental plant has been used in ponds and outdoor water gardens (Liu et al. 2010).

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1 √
Not significantly	0
Unknown	U

Once cracked open, the flesh inside the nut-like fruit can be cooked, eaten raw, or used in other foods (Lui et al. 2010a, Magness et al. 1971).
Even though this is not the water chestnut typically found in Asian cuisine, T. natans *is a food source typically used in Asia (O'Neill Jr. 2006).*
Dried nuts can be ground into flour for baking (Sturtevant and (ed) 1972).
Unfortunately, this species stores toxic compounds in the edible parts of the plant; reducing the ability of this species to be utilized as a food source (Rai and Sinha 2011).

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

The fruit has historically been used to treat conditions such as rheumatism and sunburn (Lui et al. 2010a).
In an experimental study, extracts from T. natan*s (combined with extracts from other species) decreased pain for patients suffering from shingles (Hijikata et al. 2005).*
In another study, an herbal mixture containing T. natans *brought symptom relief to those suffering herpes genitalis and labialis outbreaks (Hijikata et al. 2007).*
A peptide contained in T. natans *has anti-fungal properties (Mandal et al. 2011).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1 √
Not significantly	0

Unknown	U

The husks from T. natans *can be transformed into iron-modified activated carbon; an adsorbent compound that is able to remove chromium (VI) from wastewater (Lui et al. 2010b).*

In experiments in India, T. natans *was able to remove a significant amount of mercury from paper mill effluent (Mishra et al. 2013).*

Trapa natans *is also able to remove nitrite from the water (Rawat et al. 2012).*

Trapa natans *can remove metals from contaminated water (Baldisserotto et al. 2007, Rai and Sinha 2011).Unfortunately, this species stores the toxic compounds in the edible parts of the plant; reducing the ability of this species to be utilized as a food source (Rai and Sinha 2011).*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U √

Strayer et al. (2003) found increased diversity in epiphytic and benthic macroinvertebrates in T. natans *populations, compared to stands of native vegetation in the Hudson River (New York). Even with this increase in biodiversity, Strayer et al. (2003) concluded that these macroinvertebrates were not available to fish because of the low oxygen concentrations.*

Surveys conducted by Kornijów et al. (2010) also found dense, diverse benthic communities under floating mats of T. natans *containing insects, oligochaetes, crustaceans, and other taxa. However, Kornijów et al. (2010) determined that water chestnut beds provided valuable habitat for invertebrate biodiversity and production, and may contribute substantially to fish production.*

Beneficial Effect Total	3
Total Unknowns (U)	1

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**<u>Moderate</u>**
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

Scientific Name: *Typha angustifolia* L.

Common Name: Narrow-leaved cattail

Environmental: High
Socio-Economic: Low
Beneficial: High

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems, etc.) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Narrow-leaved cattail is thought to be allelopathic, producing chemicals that discourage growth of other plant species (Ohio EPA 2001).

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light, etc.)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes, etc.) on one or more native species populations	6 √
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U

Typha angustifolia *can out-compete native species in a variety of wetland ecosystems and its presence limits biodiversity (Forest Health Staff 2006, Ohio EPA 2001).*
High seed production and wind dispersal enable seeds to reach newly disturbed sites or areas of disturbance within a colonized site (Grace and Harrison 1986 in Miklovic 2000). Typha angustifolia *is especially invasive in disturbed wetlands and readily forms dense, monotypic stands that shade out other species (Ohio EPA 2001, Stevens and Hoag 2006).*
Narrow-leaved cattail is also tolerant of saline conditions and uses this tolerance to out-compete less tolerant species (Miklovic 2000).
When growing at a depth at or exceeding 0.25 m, populations of T. angustifolia *can expand at a rate of 1 m per year (Weisner 1993). Reports of cattail dominated habitats have greatly increased in the Midwest over the last few decades (Borland et al. 2009).*
*In studies where cattail litter was added to test sites, native wetland plants such as marsh bellflower (*Campanula aparinoide*s), bulb-bearing water-hemlock (*Cicuta bulbifera*), and stiff marsh bedstraw (*Galium tinctorium*) did not emerge. Narrow-leaved cattail has large energy reserves in its rhizomes that supply new shoots with the necessary energy to push through the litter in the spring (Vaccaro et al. 2009).*
Typha angustifolia *emerges earlier in the spring and grows more rapidly and taller than* T. latifolia*, often giving it the competitive advantage in areas where the two species coexist. In test areas,* T. angustifolia *slowly replaces* T. latifolia*, except in very shallow water (Weisner 1993).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects	6

(e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web, etc.)	
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression, etc.)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Hybridization between T. angustifolia *and* T. latifolia *results in the invasive* Typha x glauca*.*
Previously, it was thought that the hybrid was sterile and could only spread via growth of its rhizomes; however it is now known that some Typha x glauca *individuals can reproduce sexually (McKenzie-Gopsill et al. 2012, Travis et al. 2010).*
Typha x glauca *often grows larger and can tolerate a wider range of environmental conditions than either parent species (Borland et al. 2009, Galatowitsch 2012, Travis et al. 2010).*
In Hoosier Prairie Nature Preserve, Indiana T. angustifolia *and* Typha x glauca *constitute almost 100% of the vegetation in the wetlands (Indiana Lake Michigan Coastal Program 2007).*
Some experts believe T. glauca *is more invasive and problematic than* T. angustifolia *(Reeb 2007). However, coexistence of* T. angustifolia *and* T. latifolia *does not guarantee that hybridization will occur. In Ohio,* T. angustifolia *blooms 2 weeks earlier than* T. latifolia*, leaving a short period of time when cross-pollination is possible (Selbo and Snow 2004).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles, etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical), etc.)?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse	1 √

effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U

Dense root and rhizome mats produce a thick layer of litter that prohibits the growth of many other plants species (Forest Health Staff 2006). Stable water levels and stands of dead stems result in litter accumulation, which can alter nutrient levels and species diversity in benthic communities.
When Typha x glauca *individuals die, there is a substantial amount of dead shoots and litter that remains; especially in areas dense with* Typha *spp. The dead biomass effectively blocks sunlight, smothers new growth, and modifies the concentration of nutrients (Galatowitsch 2012).*

Environmental Impact Total	8
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6

Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture, etc.)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species, etc.)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1

Not significantly	0 √
Unknown	U

A stand of cattails can act as a nutrient regulator in aquatic ecosystems, taking up nutrients when they are overly abundant and releasing nutrients when there is a deficit. This regulation of nutrients can play an important role in controlling phytoplankton blooms (Mason and Bryant 1975).
Typha angustifolia *also contains three phenic acids, which act as allelochemicals and may further control algal blooms in eutrophic waters (Zhang et al. 2011).*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade, etc.)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

If collected at the appropriate stage (and in some cases cooked) all parts of the narrow-leaved cattail are edible (Stevens and Hoag 2006).
It is estimated that one acre of T. angustifolia *would yield about 6,475 pounds of flour (from the pollen) consisting of about 80% carbohydrates and 6-8% protein (Harrington 1972 in Stevens and Hoag 2006).*

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Narrow-leaved cattail pollen has been used for the treatment of dysmenorrhea, stranguria, and metrorrhagia in China (Tao et al. 2011).
Oxidative stress, which is usually associated with inflammatory bowel disease, was reduced in rats whose diets included T. angustifolia *rhizome flour (Fruet et al. 2012).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1 √
Not significantly	0
Unknown	U

Typha angustifolia *can be planted in constructed wetlands (CWs) to aid in tertiary water treatment (Stevens and Hoag 2006).*
CWs in Canada with monocultures of T. angustifolia *were able to remove between 94%-99% of the pollutants (primarily nitrogen and phosphorus) from highly concentrated fish farm waste (Gagnon et al. 2012).*
Typha angustifolia *was able to remove lead, iron, manganese, copper, zinc, and nickel from aqueous solutions and was especially effective at taking up the latter three (Chandra and Yadav 2010, Muhammad et al. 2009).*

Typha angustifolia *showed no signs of toxicity after 30 days exposure to 1 mM chromium, cadmium, or lead. During the experiments with lead, narrow-leaved cattail increased its uptake of calcium, iron, and zinc (Bah et al. 2011).*
Narrow-leaved cattail is tolerant of cadmium and may be able to remove it from soils via phytoremediation (Xu et al. 2011).
Jomjun et al. (2011) demonstrated that T. angustifolia *is capable of removing 56 mg of arsenic per m2 soil per day.*
Typha angustifolia *is tolerant of relatively high concentrations of hexachlorobenzene and its two metabolites and may therefore be useful in phytoremediation of these pollutants (Ma and Havelka 2009).*
Narrow-leaved cattail can also absorb synthetic dyes, making it a possible plant for treating complex wastewaters (Nilratnisakorn et al. 2007).
There has also been some initial success using T. angustifolia *in constructed wetlands to remove pharmaceuticals and personal care products from urban waste water (Hijosa-Valsero et al. 2011, Reyes-Contreras et al. 2012).*
Given the variety of pollutants that T. angustifolia *can absorb, it has the potential to be used in complex phytoremediation and constructed wetlands.*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable, etc.)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6 √
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U

In limited quantities, T. angustifolia *can actually be beneficial to an ecosystem by adding food and habitat diversity (Miklovic 2000).*
Its seeds are eaten by several duck species; however, they are not as nutritious those of as native species (Stevens and Hoag 2006).
Muskrats, beavers, and rats eat the stalks and roots of narrow-leaved cattail (MINN-DNR 2012).
It provides cover and nesting habitat for waterfowl and marsh birds such as the red-winged blackbird (Agelaius phoeniceus) (MNDNR 2012, Pennsylvania State Department 2006).
Stands of T. angustifolia *offer breeding ground and hiding places for numerous invertebrates and small fish (Fell et al. 2003, Olson et al. 1999).*
When planted along shorelines, this cattail can provide habitat for largemouth bass and northern pike (MNDNR 2012, United States Forest Service 2012).
Other organisms often found in stands of T. angustifolia *include leeches, crustaceans, mollusks, and insects such as dragonflies and damselflies (Olson et al. 1999, Su et al. 2007).*
For Swan Lake, Minnesota (located outside the Great Lakes watershed), it is recommended that the lake be managed to encourage T. angustifolia *expansion to help increase the biomass of macroinvertebrates for young waterfowl to eat (Olson et al. 1999).*
Typha *spp. serve as important nutrient reservoirs (Su et al. 2007).*
Narrow-leaved cattail is used in prairie wetland restoration (United States Forest Service 2012).
It can also be planted along lakes and ponds to both stabilize marsh areas and protect shores from erosion (MNDNR 2012).
Constructed wetlands (CWs) tend to emit higher levels of greenhouse gas (GHG) than natural wetlands. However, Maltais-Landry et al. (2009) reports that of the CWs tested, those planted solely with T. angustifolia *emitted the lowest levels of GHG.*

Beneficial Effect Total	7
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	**<u>High</u>**
2-5	Any	Moderate

0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Veronica beccabunga*

Common Name: European brooklime

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Can form large stands (clonal patches, Grime et al., 1988), that cover the stream and significantly reduce native riparian and wetland species (Mehrhoff et al., 2003); however, no documention of stands larger than 1/4 acre.

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1

Not significantly	0
Unknown	U √

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	3
Total Unknowns (U)	3

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √

Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

es, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High

2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1 √
Not significantly	0
Unknown	U

Grown as a bee/butterfly plant, in water gardens, and as an ornamental. Leaves are edible as a bitter green.

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6

Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

A.9 Algae

Scientific Name: *Actinocyclus normanii fo. subsalsa*

Common Name: Diatom

Environmental: Moderate
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1√
Not significantly	0
Unknown	U

Due to a high demand of silica for its heavily silicified walls, during blooms, A. normanii f. subsalsa may deplete dissolved silica concentration in shallow bays. The resulting silica-limited environment is detrimental to species of native diatoms that are dependent on silica availability and promotes the growth of harmful blue-green algae (Edlund et al. 2000, Theriot and Stoermer 1985). Sediment cores taken from Lake Ontario indicate the introduction of Stephanodiscus binderanus and A. normanii f. subsalsa *is correlated with the extirpation of native species including* S. transilvanicus, Cyclotella comta, C. michiganiana, C. ocellata, and C. stelligera *(Stoermer et al 1985).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Actinocyclus normanii f. subsalsa *was found to be a major source of particulate nitrogen in one New England estuary, where it reached 99% abundance—greater than that observed in the Great Lakes. Under these conditions*

Actinocyclus normanii f. subsalsa supported many consumers, including planktonic copepods, benthic amphipods, grass shrimp, mud crabs, alewife, and white perch (Hughes et al. 2000). It is unclear if A. normanii f. subsalsa *has a similar effect in the Great Lake populations.*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Actinocyclus niagarae *is the only other species of the same genus in the Great Lakes and no research indicates that the two species are influencing each other genetically (Stoermer and Kreis 1978).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1√
Not significantly	0
Unknown	U

Actinocyclus normanii f. subsalsa *has been associated with the depletion of dissolved silica in shallow bays and coastal areas in the Great Lakes (Edlund et al. 2000, Theriot and Stoermer 1985).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	2
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate

0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

A high abundance of A. normanii f. subsalsa *is associated with blue-green algae blooms, which can severely impact water quality (Edlund et al 2000).*

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1

Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6

It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

Actinocyclus normanii f. subsalsa *is a species that is used to identify the history of pollution in sediment cores from lakes (Stoermer et al 1985).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Bangia atropurpurea*

Common Name: red alga

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Bangia atropurpurea *can adapt to a broad range of salinities over time and can tolerate desiccation and osmotic stress. These traits* allow B. atropurpurea *to occupy the high littoral zone where other filamentous algae do not typically grow (Graham and Graham 1987, Jackson 1988, Lin and Blum 1976, Sheath and Cole 1984, Stewart 2008). There are conflicting reports about whether these characteristics allow* B. atropurpurea *to out-compete native species (Edlund et al. 2000, Stewart 2008).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

The mucilaginous cell wall of B. atropurpurea *is advantageous when living in the upper littoral zone; however, it supports approximately 1000 fewer epiphyte cells/mm2 compared to native organisms like* Cladophora *(Lowe et al. 1982). This lack of quantity and diversity of algal epiphytes could negatively impact the littoral food web. Furthermore,* B. atropurpurea *can only support larval chironomids, while native* Cladophora *supports a larger* *diversity of macroinvertebrates (Chilton et al. 1986). Whether this will have an impact on invertebrate composition hinges upon the ability of* B. atropurpurea *to outcompete* Cladophora.

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

The populations of B. atropurpurea *in the Great Lakes are limited to asexual reproduction and therefore will not affect native species genetically (Chilton et al 1986, Sheath and Cole 1984).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Bangia atropurpurea *can be a biofouling organism and has contributed to hypoxic conditions in Lake Erie (Edlund et al. 2000, Stewart 2008).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	1
Total Unknowns (U)	2

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low

1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one).

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Bangia atropurpurea *typically grows in association with* Uthorixa *and* Cladophora*. All three of these species are considered biofouling organisms (Lin and Blum 1977). There is considerable research on the negative impacts of these three macrophytes in Lake Erie, however, it is difficult to identify what impacts can be specifically attributed to* B. atropurpurea *(Chilton et al. 1986, Edlund et al. 2000, Jackson 1988, Lowe et al. 1982, Stewart et al. 2008).*

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1

Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	1

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6

It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Chaetoceros muelleri var. subsalsum*

Common Name: diatom

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Given the right water chemistry Chaetoceros muelleri var. subsalsum *is capable of sustaining abundant populations (Fuji et al. 1995). Saginaw Bay, the area of the Great Lakes where* C. muelleri var. subsalsum *was collected historically, has high nutrient levels. Water salinity is the primary factor controlling population growth rates of* C. muelleri var. subsalsum*. Nutrient conditions in Saginaw Bay, particularly regarding salinity levels, are not available and therefore limit predictions of the potential impacts of* C. muelleri var. subsalsum *(Chapra et al. 2009).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Large populations of C. muelleri *could alter predator-prey relationships, but the water conditions for a large population are not currently being met in Saginaw Bay. Depending on other restoration initiatives this could change.*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Chaetoceros muelleri var. sublasum *is the only species in the Great Lakes of this genus and there is only one other species of its order found in the Great Lakes, making hybridization unlikely.*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6

Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

Scientific Name: *Chroodactylon ornatum (ramosum)*

Common Name: red alga

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

As a part of the Cladophora *epiphyton community,* Chroodactylon ramos*um has a widespread distribution throughout Lakes Huron, Erie and Ontario. It is, however, a minor part of that community and has no recorded ecological impacts (Sheath and Morison 1982).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level	1

AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR	1

It has significantly affected human health in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact

>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Conticribra (Thalassiosira) guillardii*

Common Name: diatom

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Conticribra guillardii *has been recorded at abundances reaching 95% of the diatom community in locations outside of the Great Lakes, although it is more typically less abundant in freshwater (Hasle 1978). In the Great Lakes,* C. guillardii *has only been recorded once (Sandusky Bay, OH), and the abundance of this sample compared to the rest of the phytoplankton was not recorded (Hasle (1978).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6

Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6

Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Cyclotella atomus*

Common Name: Diatom

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Cyclotella atomus *often forms algal blooms, and in some locations outside of the Great Lakes basin, it composes 95% of the phytoplankton community (Jackson et al. 1987, Kiss 1996, Murakami et al. 1998). In portions of Lake Ontario and Lake Erie,* C. atomus *has been recorded as making up an abundant portion of the phytoplankton community, but there are no records of direct effects from competition with native species (Klarer and Millie 1994, Makarewicz 1987).*
Cyclotella atomus *thrives in a wide range of salinities, at high nutrient levels, and under small-scale turbulence (e.g., 0.38 m s−1) (Jackson et al. 1987, Weckstrom and Juggins 2006, Wang et al. 2012, Yang et al. 2005). Native diatoms in eutrophic water bodies where silica is limiting could be in competition with* C. atomus*, which has a high affinity for silica (Weckstrom and Juggins 2006).* Cyclotella atomus *has also been seen in locations with reduced algal diversity, but this is likely due to agricultural eutrophication rather than to the presence of* C. atomus*.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

There are over 50 species of Cyclotella *in the Great Lakes, but there is no known research indicating that there is any genetic interaction between* C. atomus *and native species.*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Cyclotella atomus *is often found in locations that have high levels of nutrient pollution, but it does not directly decrease water quality (Jackson et al. 1987, Stoermer and Labewski 1976, Weckstrom and Juggins 2006, Yang et al. 2005).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	1

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	

0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Within the Great Lakes basin, C. atomus *occurs primarily in shallow waters with high nutrient levels.* Cyclotella atomus *does not create eutrophic conditions, but it can contribute to the negative effects of eutrophication by further reducing silica availability for native diatoms (Stoermer and Labewski 1976, Weckstrom and Juggins 2006).*

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR	1 √

It is potentially important to medicine or research and is currently being or scheduled to be studied	
Not significantly	0
Unknown	U

The appearance of C. atomus*, along with other small planktonic diatoms, can be used as an early indicator that the water quality is deteriorating (Collins et al. 1997, Weckstrom and Juggins 2006, Yang et al. 2005). Stewart et al. (2008) used* C. atomus *as an indicator of increasing surface temperature due to climate change in Sanagak Lake, Nunavut, Canada.*
Cyclotella atomus *has also been used in paleoflood studies to identify historical floods in an attempt to enhance predictive models for extreme flood events. This same paleoflood data was used to assess the impact of climate change on flood severity and frequency (Medioli and Brooks 2003).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Cyclotella cryptica*

Common Name: diatom

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Cyclotella cryptica *can grow heterotrophically for up to one year and could potentially outcompete native species in low or no light conditions, although this has not been recorded in the Great Lakes (White 1974).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR	1

It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Cyclotella cryptica *is a euryhaline species and within the Great Lakes in found primarily in nearshore areas, bays, and river mouths that have an elevated salinity (approximately 100-160 Cl- mg/mL) due to salt pollution (Liu and Hellebust 1976, Makarewicz 1987). It does not itself affect water quality.*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6

Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1 √
Not significantly	0
Unknown	U

Cyclotella cryptica *is a species that is very important to the growing algal biofuels industry. Roessler (1988) found that C. cryptica grown in silicon-deficient conditions had significantly higher levels of lipid production. Researchers are currently attempting to genetically engineer other species of algae that contains the acetyl-CoA carboxylase enzyme found in* C. cryptica *in order to increase lipid content (Day et al. 2012).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	1
Total Unknowns (U)	0

<table>
<tr><th colspan="3">Scoring</th></tr>
<tr><td>Score</td><td># U</td><td>Impact</td></tr>
<tr><td>>5</td><td>Any</td><td>High</td></tr>
<tr><td>2-5</td><td>Any</td><td>Moderate</td></tr>
<tr><td>0</td><td>0-1</td><td rowspan="2"><u>Low</u></td></tr>
<tr><td>1</td><td>0</td></tr>
<tr><td>0</td><td>≥2</td><td rowspan="2">Unknown</td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

Scientific Name: *Cylindrospermopsis raciborskii*

Common Name: Cylindro

Environmental: Low
Socio-Economic: Moderate
Beneficial: Low

Comments: In general, populations of Cylindrospermopsis raciborskii in the Great Lakes region are small and have had relatively little impact on the environment or socio-economic factors. However, C. raciborskii is known to cause serious water quality and ecosystem health issues in other parts of the world. These impacts outside of the Great Lakes should be seriously considered as the range of C. raciborskii is expanding with global climate change. If water temperatures continue to increase and water levels continue to drop, studies suggest that these isolated populations within the Great Lake could become much more prominent (Conroy et al. 2007, Wiedner et al. 2007, Xie et al. 2007).

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Some strains of C. raciborskii *produce a variety of toxins including cylindrospermopsin, anatoxin-a, and saxitoxin. These toxins have been responsible for fish kills in a reservoir in Brazil and cattle deaths in Australia (De Souza et al. 1998, Saker et al. 1999b, Thomas et al. 1998). Cylindrospermopsin has been found to bioaccumulate in certain species of mollusks, crayfish, and snails; in some cases this exposure was toxic (Kiss et al. 2002, Saker et al. 2004, Saker and Eagleshame 1999, White et al. 2006).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

None of the populations dispersed throughout the Great Lakes basin are large enough currently to outcompete native phytoplankton species for resources (Conroy 2007, Xie et al. 2011).
At high densities (e.g., > 90% phytoplankton biomass) in more tropical climates, C. raciborskii *can cause a reduction in biodiversity. This is because of its ability to fix atmospheric nitrogen, sequester phosphorous, and move throughout the water column (Borics et al. 2000, Bouvy et al. 2001, Dobberfuhl 2003, Leonarda and Paerl 2005).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any	6

native species populations, creation of a dead end or any other significant alteration in the food web)	
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

In the St. Johns River System, Florida, C. raciborskii *appears to reduce the size and diversity of zooplankton by sequestering nutrients and making them unavailable to grazers in the water column (Leonard and Paerl 2005). Some rotifers and cladocerans exhibit reduced feeding rates, growth rates, or growth potential in the presence of* C. raciborskii (*Hawkins and Lampert 1989, Nogueira et al. 2004, Rothaupt 1991).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Treatment of a C. raciborskii *bloom with copper sulfate resulted in contamination of a reservoir on Palm Island, Australia with cylindrospermopsin. After drinking the contaminated water, 141 people were hospitalized with heptoenteritis and other symptoms affecting kidneys, adrenal glands, small intestine, lungs, thymus, and heart (Bernard et al. 2003, Bouke et al. 1983, Hawkins et al. 1985). There is also accumulating evidence that cylindrospermopsin is carcinogenic (Falconer and Humpage 2001).*

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Strains of C. raciborskii *that produce toxins can severely impact water quality both in drinking water for humans and as a result of bioaccumulation in aquatic organisms (Bernard et al. 2003, Bouke et al. 1983, Hawkins et al. 1985, Kiss et al. 2002, Saker et al.2004, Saker and Eagleshame 1999, White et al. 2006).*

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small	1

AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

There are multiple reports of toxic C. raciborskii *blooms occurring in aquaculture ponds in Australia and other tropical regions. This often results in bioaccumulation of cylindrospermopsin within the organisms intended for harvest and the economic loss of infected organisms. Such blooms also create a risk of the toxin getting into the human food market if not detected soon enough (Saker and Eaglesham 1999).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Cylindrospermopsin is an irritant and causes cutaneous sensitizing that could be harmful to recreational users of impacted water bodies; to date, however, populations in the Great Lakes basin have not been known to produce cylindrospermopsin (Stewart et al. 2006).

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

In areas outside of the Great Lakes, the overwhelming biomass of C. raciborskii *blooms in association with the changes to the biodiversity of the system can potentially have a negative impact the natural value of the area (Leonard and Paerl 2005).*

Socio-Economic Impact Total	2
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √

Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered species, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**

1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Diatoma ehrenbergii*

Common Name: diatom

Environmental: Low
Socio-Economic: Low
Beneficial: Low

Comments: Diatoma ehrenbergii was recorded at relatively low levels in eutrophic areas of Lake Michigan, Saginaw Bay, and Lake Huron (Mills et al. 1993, Stoermer and Yang 1969). As such, the extent of any impacts is likely to be limited.

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual	1

level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe	1

AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring

Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered species, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Discostella pseudostelligera*

Common Name: Diatom

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

In Arizona, D. pseudostelligera *has been reported to outcompete other diatoms for light in under high light intensity conditions. This has not been observed in the Great Lakes (Czarnecki 1979).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR	1

It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

There are over 50 species of Discostella *in the Great Lakes, but there is no known research indicating that there is any genetic interaction between* D. pseudostelligera *and native species.*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Discostella pseudostelligera *is often found in locations that have elevated levels of nutrient pollution, but it does not directly decrease water quality (Finney et al. 2000, Reynolds et al 2002, Stoermer and Yang 1969, 1970, Stoermer and Ladewski 1976).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1

Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

<u>BENEFICIAL EFFECT</u>

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1 √
Not significantly	0
Unknown	U

The appearance and increased abundance of D. pseudostelligera*, along with other small planktonic diatoms, can be used as a historical indicator of pollution and changing water quality (Bere and Tundisi 2011, Lim et al. 2001, Moser et al. 2010, Pappas 2010).*
Discostella pseudostelligera *has also been used in Arctic lakes as an indicator of climate change (Kiarst-Riddoch et al. 2005).*

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Discotella woltereckii*

Common Name: Diatom

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Discostella woltereckii *occurs in meso-eutrophic to eutrophic conditions, reaching high densities in locations outside of the Great Lakes. As such, it has the potential to out-compete native phytoplankton under nutrient rich conditions (Wojtal et al. 2005).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Discostella woltereckii *occurs in meso-eutrophic to eutrophic conditions, reaching high densities in locations outside of the Great Lakes. These high densities could interfere with trophic level interactions but there is not currently any research on the topic (Wojtal et al. 2005).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the	6

decline or extinction of one or more native species	
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Discostella woltereckii *grows nonindigenously in artificial drainage systems in some locations outside of the Great Lakes, forming thick mats that could potentially clog drains and disrupt water transportation (Kastovsky et al. 2010). While this species is not currently a problem in the Great Lakes basin, in higher densities, it could pose a threat to the functionality of infrastructure.*

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √

Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	1

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or	6

native species	
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered species, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Hymenomonas roseola*

Common Name: Coccolithophorid

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

Comments: Hymenomonas roseola can reach high abundances in ponds, small lakes, and the backwaters of polluted rivers, particularly in eutrophic conditions. Hymenomonas roseola is unlikely to have similar abundances in large lakes, so it is unclear if it will have similar negative impacts in the Great Lakes (Stoermer and Sicko-Goad 1977).

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Hymenomonas roseola *can reach high abundances in ponds, small lakes, and the backwaters of polluted rivers, particularly in eutrophic conditions.* Hymenomonas roseola *does not have a high success rate in large lakes (Stoermer and Sicko-Goad 1977).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

Hymenomonas roseola *can reach high abundances in ponds, small lakes, and the backwaters of polluted rivers, particularly in eutrophic conditions. In instances of high abundance, the impact of* H. roseola *on predator-prey relationships is unknown. The impact on predator-prey relationships is less likely in the Great Lakes because* H.

roseola *is known to occur primarily in the littoral region of larger lakes and does not reach high abundances in large bodies of water (Stoermer and Sicko-Goad 1977).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

The only species of the genus Hymenomonas *in the Great Lakes is* H. roseola, *and there is only one other species of its order found in the Great Lakes, making hybridization unlikely.*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

Hymenomonas roseola *thrives in eutrophic conditions, exacerbating problems associated with nutrient pollution. The presence of* H. roseola *is an effect of eutrophication, however, and not a cause.*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	3

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low

1	0	
0	≥2	**Unknown**
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1

Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered species, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

<table>
<tr><th colspan="3">Scoring</th></tr>
<tr><td>Score</td><td># U</td><td>Impact</td></tr>
<tr><td>>5</td><td>Any</td><td>High</td></tr>
<tr><td>2-5</td><td>Any</td><td>Moderate</td></tr>
<tr><td>0</td><td>0-1</td><td rowspan="2"><u>Low</u></td></tr>
<tr><td>1</td><td>0</td></tr>
<tr><td>0</td><td>≥2</td><td rowspan="2">Unknown</td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

Scientific Name: *Nitellopsis obtusa*

Common Name: starry stonewort

Environmental: Moderate
Socio-Economic: High
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Mats of N. obtusa *can act like a commercial benthic barrier and lead to the accumulation of phytotoxins that could create redox conditions; these conditions have a reduced impact on the rootless* N. obtusa *as compared to native species (Pullman and Crawford 2010).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

When it was first reported, N. obtusa *was the ninth most frequently collected macrophyte in the St. Clair-Detroit River system (Mills et al. 1993, Nicholls et al. 1988). It was recorded at a peak biomass of 259 g m-2 in September, when many other macrophytes were declining, giving it a competitive advantage (Nicholls et al. 1988, Schloesser et al. 1986).*
Once established in inland lakes, N. obtusa *forms dense mats of vegetation that completely cover the lake bottom. Mats of* N. obtusa *correspond with a dramatic decrease in the biomass of competing species. Although specific surveys have not been conducted yet, there is serious concern for inland lake populations of native species that are dependent on lake bottom habitat, including minnows, logperch, darters, clams, and other invertebrates (Pullman and Crawford 2010).*
There is also research indicating that macrophyte species have a strong influence on phytoplankton through allelopathic interactions (Hilt et al. 2010, Mulderij et al. 2007, Pullman and Crawford 2010).
In Sweden, N. obtusa *dies off in the winter, which reduces the ability of slow colonizers like the isopod Asellus and amphipod Gammarus to establish significant populations in this habitat. As a result, it typically hosts many chironomids, while* Chara tomentosa *harbors more amphipods and isopods (Hargeby 1990).*
Dense mats of N. obtusa *directly impact the habitat used by native fish for spawning. Bass and sunfish are known to regularly spawn in dense growths of native* Chara *species, but these spawning behaviors did not occurs in correspondingly dense growths of* N. obtusa *(Pullman and Crawford 2010).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

There is no indication that N. obtusa *is affecting Great Lakes native populations genetically, but it has been proposed that the population of* N. obtusa *in the Great Lakes represents a unique phenotype from its native population in Europe (Pullman and Crawford 2010).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Nitellopsis obtusa *has been associated with increased water clarity in inland lakes, which could in part be due to their association with zebra mussels (*Dreissena polymorpha*) as a favored substrate. In spite of increased water clarity from the mussels, the dense growth of* N. obtusa *actually reduces light availability for other submersed flora (Pullman and Crawford 2010).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

In Lake Majcz Wielki, Poland, zebra mussels settle at densities of 1000 per m2 on N. obtusa *and* Stratiotes aloides, *and at much lower densities on other plants (Lewandowski and Ozimek 1997).*

Environmental Impact Total	4
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

While N. obtusa *negatively affects water quality for other macrophyte and phytoplankton species, there is no evidence to suggest that the quality of drinking water is significantly affected. However, there have been no studies conducted to specifically address this issue.*

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6 √
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U

There is a large economic investment from inland lake communities to manage and control invasions of N. obtusa*. This is both to protect boat owners from potential damage to their vessels, as well as to maintain economically important recreational fishing and swimming areas (Pullman and Crawford 2010).*
Nitellopsis obtusa *also poses a risk of entanglement to swimmers, who also are displeased with this alga's rough texture.*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

Nitellopsis obtusa *is a relatively new invasion, particularly to the inland lakes. The long-term impacts on the economic value lake property cannot yet be properly assessed.*
As one of the filamentous algae that frequently detaches from the bottom to form a floating mat, N. obtusa *contributes both to lake "scum" and mats that wash up on beaches*.

Socio-Economic Impact Total	7
Total Unknowns (U)	1

Scoring		
Score	# U	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

BENEFICIAL EFFECT

Does it ac as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1 √

Not significantly	0
Unknown	U

Nitellopsis obtusa *is becoming regarded as the most aggressive invasive species in inland lakes and has been recorded replacing other nonnative and nuisance species, including Eurasian watermilfoil* (Myriophyllum spicatum), *fanwort* (Cabomba caroliniana), *and curly leaf pond weed* (Potamogeton crispus) *(Pullman and Crawford 2010). Hilt et al. (2010) suggested that* N. obtusa *could be an effective means of restoration for deep lakes in its native range.*
It is known to have allelopathic properties towards cyanobacteria (Berger and Schagerl 2004).

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Nitellopsis obtusa *has a significant stratigraphical account that extends back to the early Quaternary and can be useful in biogeographical research, and well as in tracing evolutionary lineages (Soulie-Marsche et al. 2002).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Nitellopsis obtusa *is considered a rare species in Japan and parts of Europe (Blindow 1994, Golombek 1998, Kato et al. 2005 Raabe 2006, Simons et al. 1994).*

In European regions, this species can be a good substrate for epiphytes, even though it is frequently covered in marl, which is a byproduct of photosynthesis formed when bicarbonate is used (Brindow 1987).
Nitellopsis obtusa *increases in the Netherlands have been associated with increases in populations of red-crested pochards (Netta rufina), which feed preferentially on this species, possibly because it is a good source of calcium and sulfur (Ruiters et al. 1994).*

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Pleurosira laevis*

Common Name: Diatom

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Pleurosira laevis *has been recorded to dominate phytoplankton assemblages in other locations in the United States. However, these occurrences were in stream ecosystems and it is unclear if* P. laevis *is capable of out-competing native species in Lake Michigan (Crayton and Sommerfeld 1979). Additionally Ferreira et al. (1999) documented* P. laevis *growing in homogenous communities with low species richness in Portugal. The population recorded in Lake Michigan by Wujek and Welling (1981) composed approximately 1% of the overall algal abundance and was co-dominant with several native taxa.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

The abundance of P. laevis *and association with* Cladophora *in tributary environments could impact predator-prey relationships by limiting nutrient and light resources for native algal species. However, presently there is no conclusive research on these trophic interactions and it is not apparent if it would be possible in the Lake Michigan ecosystem (Kociolek et al. 1983).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Pleurosira laevis *is the only species in its genus in the Great Lakes making hybridization unlikely.*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

It is not clear if P. *laevis alters water quality. However, this species was found close to a water treatment plant in Lake Michigan and has been observed in other locations where chloride or nitrogen concentrations were elevated (Wujek and Welling 1981).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	2

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	**<u>Unknown</u>**

1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0√
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6

Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0
Unknown	U √

Pleurosira laevis *might act as an indicator of poor water quality, as it thrives in water with increased nitrate or chloride (Smucker 2011).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered species, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	1

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Skeletonema potamos*

Common Name: diatom

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U√

Skeletonema potamos *has been recorded at densities up to 20,140 cells/ml in the Little Miami River, Cincinnati, OH. In the late summer, during the highest density,* S. potamos *accounted for approximately 35% of the centric diatoms in the Little Miami River (Weber 1970).* Skeletonema potamos *is considered a pollution tolerant species and may be more productive than native species in polluted waters (Nicholls et al. 1983). The implications of competition with the native diatom taxa were not specifically investigated.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0√
Unknown	U

Skeletonema potamos *grows in relatively short (1-10 cells) chains. In polluted water S. potamos grew in chains 2-4 cells long and under those conditions was considered a functional food chain species (Nicholls et al. 1983). The presence of this species as a food source has not been addressed with regards to the specific impact on predators or other prey species.*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	1

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1

Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

Skeltonema potamos *does not directly impact water quality; however, as a pollution tolerant species it can often be used as an indicator of poor water quality (Nicholls et al. 1983).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Skeletonema subsalsum*

Common Name: Diatom

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Skeletonema subsalsum *was recorded to be 17.6% of the biomass in the spring diatom blooms in Lake Erie. These blooms were dominated by native taxa and there was no indication that* S. subsalsum *was out-competing native species (Reuter 1979). In its native range,* S. subsalsum *occurs in brackish waters. While it is able to grow and reproduce in freshwater,* S. subsalsum *does not undergo cell enlargement in freshwater as it does in brackish environments (Balzano et al. 2011).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6

Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6

Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Sphacelaria fluviatilis*

Common Name: Brown alga

Environmental: Low
Socio-Economic: Low
Beneficial: Low

Comments: Limited research has been conducted on the population of Sphacelaria fluviatilis in Gull Lake, Michigan. It was identified over 40 years ago, and while a population is still present, it does not seem to be expanding because it only undergoes vegetative reproduction.

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

The population in Gull Lake, Michigan is small and unlikely to provide a significant food for any lake herbivores (Wehr and Sheath 2003).

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the	6

decline or extinction of one or more native species	
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

The population of Sphacelaria fluviatilis *in Gull Lake, MI is not known to reproduce sexually and therefore is not expected to affect the genetic composition of native algal populations (Wujek et al. 2006).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √

Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or	6

native species	
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

<table>
<tr><td colspan="3">Scoring</td></tr>
<tr><td>Score</td><td># U</td><td>Impact</td></tr>
<tr><td>>5</td><td>Any</td><td>High</td></tr>
<tr><td>2-5</td><td>Any</td><td>Moderate</td></tr>
<tr><td>0</td><td>0-1</td><td rowspan="2"><u>Low</u></td></tr>
<tr><td>1</td><td>0</td></tr>
<tr><td>0</td><td>≥2</td><td rowspan="2">Unknown</td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

Scientific Name: *Sphacelaria lacustris*

Common Name: Brown alga

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Sphacelaria lacustris *was originally reported in Lake Michigan at depths ranging from 5-15 m (Schloesser and Blum 1980). At the time of that study it was not interfering with the growth of the native* Cladophora glomerata, *which created a dense cover on rocks at depths of 1-5 m. Since the* Dreissena *invasion and increased penetration of sunlight,* Cladophora *now can be found at depths greater than 20 m (C. Brooks pers. comm., Malkin et al. 2008). There has been no more recent research to assess* S. lacustris *impacts on* Cladophora *given this expanded range of suitable habitat.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the	6

decline or extinction of one or more native species	
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Sphacelaria lacustris *does not reproduce sexually in the Lake Michigan population and is therefore unlikely to affect native populations genetically (Schloesser and Blum 1980).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6

Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Stephanodiscus binderanus*

Common Name: Diatom

Environmental: Moderate
Socio-Economic: Moderate
Beneficial: Low

Comments: A recent study conducted by Hawrshyn et al. (2012) in Lake Simcoe, Ontario found historical microfossils of S. binderanus dating back the 17th century. This discovery brings the status of S. binderanus as a nonindigenous species in the Great Lakes basin into question. Stephanodiscus binderanus may be better classified as a range expander rather than as a nonidigenous species.

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

Stephanodiscus bineranus *thrives in phosphorous rich and silica depleted waters. It reached peak abundance in Lake Michigan and Lake Ontario in the 1950s and 1960s, but since efforts to improve water quality began in the 1970s and grazing from the Dreissena invasion increased in the 1980s, there have been marked declines in* S. binderanus *populations (Barbiero et al. 2006, Stoermer et al. 1996). In a more recent survey conducted in 2001,* S. binderanus *was not found Lakes Superior, Michigan, or Huron. However,* S. binderanus *was present in Lake Ontario and had a few very large populations in Lake Erie reaching biovolumes of 32,028 ug/mL (Barbiero and Tuchman 2001).*

The introduction and establishment of S. binderanus, *along with* Actinocyclus normanii f. subsalsa, *were accompanied by the reduction of five native diatoms* (S. transilvanicus, Cyclotella comta, C. michiganiana, C. ocellanta, *and* C. stelligera) *in Lake Ontario (Edlund et al. 2000, Stoemer et al. 1985). While it is unclear if these local population reductions were due entirely or in part to competition with exotic taxa, the appearance of* S. binderanus *in Lake Ontario spring diatom collections tends to be associated with the absence or rare occurrence of* C. comta, C. michiganiana, C. ocellanta, *and* C. stelligera *(USEPA 2012). These native species reappear at sample sites in summer, when* S. binderanus *is no longer found (USEPA 2012), suggesting that strong seasonal competition may drive fluctuations in native diatom abundances.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects	6

(e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High

2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Stephanodiscus binderanus *has clogged filters at water filtration plants in both Chicago and Montreal (Brunel 1956, Stoermer and Yang 1970, Vaughn 1961).*

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Stephanodiscus binderanus *has caused taste and odor problems at water filtration plants within the Great Lakes (Stoermer et al. 1996).*
At high abundances, S. binderanus *reduces water quality (Stoermer et al. 1985).*

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

Stephanodiscus binderanus *forms surface scums and, at high abundances, negatively affects recreational uses of the lake (Stoermer et al. 1985).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

Stephanodiscus binderanus *forms surface scums and, at high abundances, negatively affects recreational uses of the lake (Stoermer et al. 1985).*

Socio-Economic Impact Total	4
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**<u>Moderate</u>**
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

<u>BENEFICIAL EFFECT</u>

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

Stephanodiscus binderanus *has been used to assess historical pollution and climate conditions both in the Great Lakes and in Lake Baikal, Russia (Edlund et al. 1995, Stoermer et al. 1985).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Stephanodiscus subtilis*

Common Name: diatom

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Stephanodiscus subtilis *has been recorded as an abundant diatom taxon in Lake Erie and Lake Ontario during summer and early fall blooms (Mille and Lowe 1983). However, the specific impact of these blooms on native species was not investigated.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level	1

AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	1

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR	1

It has significantly affected human health in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

The distribution of S. subtilis *has been primarily nearshore areas or eutrophic waters with a considerable amount of chloride contamination, but it does not itself cause a reduction in water quality (Stoermer and Yang 1970).*

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring

Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0
Unknown	U √

Stephanodiscus subtilis *may serve as an indicator of poor water quality (Stoermer and Yang 1970).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	1

<table>
<tr><th colspan="3">Scoring</th></tr>
<tr><td>Score</td><td># U</td><td>Impact</td></tr>
<tr><td>>5</td><td>Any</td><td>High</td></tr>
<tr><td>2-5</td><td>Any</td><td>Moderate</td></tr>
<tr><td>0</td><td>0-1</td><td rowspan="2"><u>Low</u></td></tr>
<tr><td>1</td><td>0</td></tr>
<tr><td>0</td><td>≥2</td><td rowspan="2">Unknown</td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

Scientific Name: *Thalassiosira baltica*

Common Name: diatom

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

The introduction and establishment of T. baltica *were accompanied by the extirpation of the native diatom* Stephanodiscus niagarae *in Lake Ontario, both estimated as occurring around 1988 (Edlund et al. 2000, Julius et al. 1998). It is not clear whether* T. baltica *caused this local extinction or if lake change or another biological explanation (e.g., silica limitation inhibiting sexual reproduction in* S. niagarae) *drove the observed species turnover (Edlund et al. 2000).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6

Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	1

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6

Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Thalassiosira lacustris*

Common Name: diatom

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

There have been reports of blooms of T. lacustris *in Tokyo Bay, but these high densities have never been recorded in the Great Lakes basin (Hasle 1978).*
It is able to survive at salinities as low as 0.5‰ but only grows rapidly above 8‰. This is likely a limiting factor on the distribution of T. *lacustris in the Great Lakes (Hasle 1978).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual	1

level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe	1

AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring

Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

Scientific Name: *Thalassiosira pseudonana*

Common Name: diatom

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Thalassiosira pseudonana *has been found in the Great Lakes basin composing 31% of the periphyton community and 90% of the plankton community (Lowe and Busch 1975). McQuoid (2005) reported growth of* T. pseudonana *after 2 years in storage, indicating the presence of a dormant state that seems to be triggered by temperature and light cues. This dormant state could give* T. pseudonana *a competitive advantage over native species, however this has not been specifically researched.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6

Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6

Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring

Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Thalassiosira pseudonana *was found to be useful for mariculture because it has a high fatty-acid compostion (Volkman et al. 1989).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

Thalassiosira *pseudonana is used as a model organism for silica biomineralization because its entire gene sequenced has been published. Biomineralizaton is a growing field that is using diatoms to accelerate silica formation and form macromolecular assemblies that might act as structure-directing templates (Sumper and Brunner 2008).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or	6

native species	
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Thalassiosira weissflogii*

Common Name: diatom

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Outside the Great Lakes, T. weissflogii *is one of several species that has been associated with red tides (Yamaoka et al 1998). In California,* Thalassiosira sp. *was reported to clog the gills of fish during these red tide events, which led to a reduction in fish populations (Núñez-Vázquez et al. 2011).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Stoermer (1978) reported T. weissflogii *as a common diatom along the shores of Lake Michigan and bays of Lakes Erie and Ontario. The distribution of* T. weissflogii *thrives at salinities ranging from 5‰ to marine conditions, but this physiological requirement limits its distribution and impact.*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the	6

decline or extinction of one or more native species	
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Thalassiosira weissflogii *has a high lipid content, which makes it a viable option for mariculture (Ishida et al. 2000).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1 √

Not significantly	0
Unknown	U

Thalassiosira weissflogii *has a high tolerance for CO_2, making it a good candidate eliminating CO_2 during treatment of emissions from industrial factories (Ishida et al. 2000).*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Ulva flexuosa subsp. flexuosa and flexuosa subsp. paradoxa*

Common Name: green alga

Environmental: Moderate
Socio-Economic: Moderate
Beneficial: Moderate

Comments: Ulva flexuosa is considered primarily a marine species but has a wide range of salinity and nutrient tolerance. The Great Lakes range of U. flexuosa is currently limited to Muskegon, Mona and White Lake. However, as it is able to form blooms in Muskegon Lake—which has a lower conductivity than Lake Erie—there is potential for it to thrive in other locations in the Great Lakes (Lougheed and Stevenson 2004).

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1 √
Not significantly	0
Unknown	U

The first recorded bloom of U. flexuosa *in the Great Lakes occurred in Muskegon Lake, where it dominated the macrophyte community.*
Ulva flexuosa *supports a relatively low density and diversity of epiphytes compared to native macrophytes (Lougheed and Stevenson 2004). Blooms of* U. flexuosa *in Europe have been associated with the extirpation of species of red algae and epiphytes (Schories and Lotze 1997).*
It is hypothesized that shading of macrophytes could become problematic in Great Lakes if blooms were sustained for long periods of time (Lougheed and Stevenson 2004).

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1

Not significantly	0 √
Unknown	U

When U. flexuosa *blooms in nutrient rich marine coastal areas, a decline in biodiversity of native algae has been observed, as well as cascading food web effects that negatively impact macro invertebrates, shorebirds and fish (Lougheed and Stevenson 2004).*
If U. flexuosa *was to replace* Oedogonium *and* Cladophora, *which support many diatoms, food webs depending on such epiphytes could be negatively affected (Lougheed and Stevenson 2004).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Ulva flexuosa *has formed dense, free floating mats during bloom conditions in Muskegon Lake. In other locations, mats of U. flexuosa have also impacted abiotic conditions, as the dense algal cover alters redox conditions and chemical interactions between the sediment and water column (Lougheed and Stevenson 2004).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	2
Total Unknowns (U)	0

Scoring		
Score	# U	Impact

>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Ulva flexuosa *is known to foul a variety of permanent man-made structures and boats. This can lead to expensive repairs of fouled boat motors. There are even reports of it growing on boats treated with antifouling paint (Kolwalker et al. 2007, Lougheed and Stevenson 2004).*

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Mats of U. flexuosa *washed up on the shores of Muskegon Lake during the bloom of 2003. In addition to the cost to boat users, these blooms also decreased the value of lakeshore property and discouraged tourism (Lougheed and Stevenson 2004).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

Mats of U. flexuosa *washed up on the shores of Muskegon Lake during the bloom of 2003 discouraged beach use by tourists (Lougheed and Stevenson 2004).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	3
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or	6

tourism	
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

Ulva flexuosa *is used as a bioindicator for metal contamination, including lead and iron (Ho 1987, Tabudravu et al. 2002).*

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1 √
Not significantly	0
Unknown	U

Ulva flexuosa *was found to be an economically efficient species for bioabsorption in industrial settings. It could be used as an eco-friendly alternative for wastewater treatment in dye manufacturing, tannery, textile, and cosmetic industries (Sivasamy et al. 2012).*

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	2
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**<u>Moderate</u>**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Ulva intestinalis*

Common Name: green alga, grass kelp, gut weed

Environmental: Moderate
Socio-Economic: Low
Beneficial: Low

Comments: Ulva intestinalis had caused serious negative impacts in marine and coastal areas outside of the Great Lakes region. However, the harmful bloom development seen in marine environments is rare in inland, freshwater populations (Messyasz and Rybak 2011).

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Ulva intestinalis *has the potential to be a superior macrophyte competitor. Lotze et al. (2000) found that this species can produce a propagule bank capable of surviving winter conditions in the Baltic Sea. Such a seed bank allowed* U. intestinalis *to begin growing two months earlier than many native species, enabling it to escape herbivory and nutrient competition.*
In Indian coastal areas, filamentous forms of U. intestinalis *have been associated with lower faunal community diversity than areas with more bushy algae (Yogamoorthi 1998).*
In European coastal waters, epiphytic benthic diatoms prefer growing on monosiphonous forms of U. prolifera *to colonizing broad and flattened forms of* U. intestinalis (Holt 1980).
Epibionts like Ulva *can also exert increased drag on snails living in high flow conditions, causing them to invest more energy in foot muscles and less in growth (Wahl 1996).*
In conditions of nitrogen scarcity in estuaries and lagoons on the coast of southern California, U. intestinalis *can out-compete* Ulva expansa (Fong et al. 1996).

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species	1

population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	
Not significantly	0 √
Unknown	U

In marine and coastal waters, U. intestinalis *may form green tides and biofouling mats that cause cascading effects throughout the food web.* Ulva intestinalis *mats can deplete the available oxygen in the water and increase the production of hydrogen sulphide in the sediment, which can cause population declines in other fauna and flora (Bäck et al. 2000, Cummins et al. 2004, Vadas and Beal 1987).*
Mats can also shade out native seagrass beds and negatively impact their corresponding communities, as well disrupt feeding by wading birds (Raffaeli et al. 1998).
Furthermore, some marine forms of U. intestinalis *are more difficult for grazers to handle and ingest than species with more frond structure (Watson and Norton 1985).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Ulva intestinalis *mats can deplete the available oxygen in the water and increase the production of hydrogen sulphide in the sediment (Baeck et al. 2000).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Romano et al. (2003) observed in England an increase in friction drag with the presence of Ulva intestinalis *mats, causing a 10% to 56% reduction in current velocities. There was also a significant reduction is sediment erosion.*

Environmental Impact Total	2
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR	1 √

It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U

Mats of U. *intestinalis in England caused an order of magnitude decrease in abundance of the economically important bivalve* Cerastoderma edule *(Romano et al. 2003).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Ulva intestinalis *is one of the species that contributes to the 109 kg of seaweed removed every year from recreational beaches in France (Blomster et al. 2002).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √

Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

Scientific Name: *Ulva prolifera*

Common Name: sea lettuce

Environmental: Low
Socio-Economic: Low
Beneficial: Low

Comments: While blooms of U. prolifera have had significant negative environmental and socio-economic impacts in Asia (Xu et al. 2012), these impacts have not been realized in the Great Lakes. Moreover, the persistence of a population in the Great Lakes region is still uncertain.

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

In recent years, large blooms (over 1 million tons) of Ulva prolifera *have lead to declines in seagrass beds due to shading, disruption of feeding by wading birds, and an overall loss of algal biodiversity (Xu et al. 2012). These negative effects have not been realized in the Great Lakes because of the small and uncertain nature of the* U. prolifera *population (Mills et al. 1993).*
Ulva prolifera *mats that formed on intertidal sandflats in Scotland were found to significantly decrease the macrofaunal diversity. These negative impacts were particularly on species that use planktonic larval recruitment (Bloam et al. 2000).*
Ulva prolifera *has been found to release allelochemicals that inhibited growth and photosynthesis in native competitors (Xu et al. 2012).*
In intertidal flats of the Wadden Sea, dense mats of E. prolifera *and other* Enteromorpha *spp. have been associated with fewer occurrences of brown and red algae (Schories et al. 1997).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population	1

AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

In China, massive blooms covered large extents of the sea bottom (13,000-30,000 km2) and decoupled biogeochemical cycles between the sediments and the water column. These chemical changes exposed native flora and fauna to oxygen deficiency and anoxia (Xu et al. 2012).

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High

2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

China has been experiencing an increase in U. prolifera*-dominated green tides since 2007, with a notable event just prior to the 2008 Beijing Olympics. There were significant impacts on the tourism industry as well as on aquaculture. The cost for emergency mitigation action in China during the 2008 bloom was estimated to cost around 200 million Euro. According to Nai-hao et al. (2011) green tides are responsible for aquaculture losses of approximately 86 million Euro annually.*
In Spanish waters, U. prolifera *is one of the species responsible for fouling intertidal oyster culture systems, although this problem can be partly controlled by snail grazing (Cigarria et al. 1998).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

China has been experiencing an increase in U. prolifera-*dominated green tides since 2007, with a notable event just prior to the 2008 Beijing Olympics. There were significant impacts on the tourism industry (Nai-hao et al. 2011).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Zhuang et al. (2012) proposed the use of U. prolifera *as green feedstock, biofuel substitute, and chemical production.* Ulva prolifera *is edible and is considered an economically viable food option in Japan and China (Dan et al. 2002).*

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

A.10 Amoebae

Scientific Name: *Psammonobiotus communis*

Common Name: Testate amoeba

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Psammonobiotus communis *was first detected in the Great Lakes through surveys of beach sand in 2001 and 2002, in which this amoeba was the most abundant psammobiont (obligate sand-dwelling) testate rhizopod collected (> 100 specimens total) (Nicholls and MacIsaac 2004). However, compared to abundance in marine beaches, the density of* P. communis *in the Great Lakes has been relatively low (Nicholls and MacIsaac 2004).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

While the impacts of P. communis *in the Great Lakes have not yet been studied, testate amoebae tend to prey upon and modify microbial populations, accelerate nutrient cycling, and be consumed by other organisms (e.g., Lousier and Parkinson 1984, Schönborn 1992).*

Furthermore, selective grazing by testate amoebae may influence microbial community taxonomic composition and metabolic activity (Bonkowski 2004, Sherr et al. 1992).

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

While the impacts of P. communis *in the Great Lakes have not yet been studied, testate amoebae tend to prey upon and modify microbial populations, accelerate nutrient cycling, and be consumed by other organisms (e.g., Lousier and Parkinson 1984, Schönborn 1992).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	3

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	

0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6

Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

In studies outside the Great Lakes, testate amoebae have been used as indicators of ecosystem condition and function (e.g., Fournier et al. 2012).

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Psammonobiotus dziwnowi*

Common Name: Testate amoeba

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0
Unknown	U √

Psammonobiotus *dziwnowi was first detected in the Great Lakes through surveys of beach sand in 2001 and 2002 at "moderate" numbers (63 individuals total) (Nicholls 2005, Nicholls and MacIsaac 2004). However, compared to abundance in marine beaches, densities of psammobiont testate rhizopods in the Great Lakes are relatively low (Nicholls and MacIsaac 2004).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0
Unknown	U √

While the impacts of P. dziwnowi *in the Great Lakes have not yet been studied, testate amoebae tend to prey upon and modify microbial populations, accelerate nutrient cycling, and be consumed by other organisms (e.g., Lousier and Parkinson 1984, Schönborn 1992).*
Furthermore, selective grazing by testate amoebae may influence microbial community taxonomic composition and metabolic activity (Bonkowski 2004, Sherr et al. 1992).

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U √

While the impacts of P. dziwnowi *in the Great Lakes have not yet been studied, testate amoebae tend to prey upon and modify microbial populations, accelerate nutrient cycling, and be consumed by other organisms (e.g., Lousier and Parkinson 1984, Schönborn 1992).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	3

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	**Unknown**
1	≥1	**Unknown**

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6

Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

In studies outside the Great Lakes, testate amoebae have been used as indicators of ecosystem condition and function (e.g., Fournier et al. 2012).

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

Scientific Name: *Psammonobiotus linearis*

Common Name: Testate amoeba

Environmental: Unknown
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Psammonobiotus linearis *was first detected in the Great Lakes through surveys of beach sand in 2002 at "low" numbers (Nicholls and MacIsaac 2004). Compared to abundance in marine beaches, densities of psammobiont testate rhizopods in the Great Lakes are relatively low overall (Nicholls and MacIsaac 2004).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

While the impacts of P. linearis *in the Great Lakes have not yet been studied, testate amoebae tend to prey upon and modify microbial populations, accelerate nutrient cycling, and be consumed by other organisms (e.g., Lousier and Parkinson 1984, Schönborn 1992).*
Furthermore, selective grazing by testate amoebae may influence microbial community taxonomic composition and metabolic activity (Bonkowski 2004, Sherr et al. 1992).

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

While the impacts of P. dziwnowi *in the Great Lakes have not yet been studied, testate amoebae tend to prey upon and modify microbial populations, accelerate nutrient cycling, and be consumed by other organisms (e.g., Lousier and Parkinson 1984, Schönborn 1992).*

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown

1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the	6

natural or cultural character of the area, or significantly reduced the area's value for future generations	
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

In studies outside the Great Lakes, testate amoebae have been used as indicators of ecosystem condition and function (e.g., Fournier et al. 2012).

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

A.11 Parasites & Diseases

Scientific Name: *Acineta nitocrae*

Common Name: A suctorian ciliate

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Acineta nitocrae *is commensal with the Great Lakes nonindigenous copepods* Nitokra hibernica *and* N. incerta *(Grigorovich et al. 2001). However, high densities could potentially affect hosts' exoskeletons, movement, respiration, nutrient uptake, and reproduction (Grigorovich et al. 2001). With the exception of Lake Superior,* Nitokra *species are abundant throughout the Great Lakes. It is possible that these copepods will transport* A. nitocrae *to Lake Superior if they continue to spread (Grigorovich et al. 2001, Hudson et al. 1998, Lesko et al. 2003).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0

Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6

Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

Scientific Name: *Aeromonas salmonicida*

Common Name: Furunculosis, ulcer disease, erythrodermatitis

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

In the Great Lakes and connecting tributaries, A. salmonicida *has had a larger impact on native salmonids than on introduced salmonids. It particularly affects Atlantic salmon* (Salmo salar), *brook char or trout* (Salvelinus fontinalis), *lake char* (Salvelinus namaycush), *grayling* (Thymallus arcticus), *and lake whitefish* (Coregonus clupeaformis). *It secondarily affects other native non-salmonid species such as northern pike* (Esox lucius), *yellow perch* (Perca flavescens), *dace and minnows (Family Cyprinidae), catfish (Family Ictaluridae), sticklebacks (Family Gasterosteidae), and sculpins (Family Cottidae) (Crawford 2001, Mills et al. 1993).* Aeromonas salmonicida *has been found to be ubiquitous and established in commercial fish farms, government fish hatcheries, and wild populations throughout the Great Lakes and connecting tributaries (Bruneau et al. 1999). However, the bacterium continues to be detected at very low prevalence (GLFHC 2006).*
In 2011, A. salmonicida *was isolated from a Michigan state hatchery for the first time since 2005 and was detected in 2% of returning adult Atlantic salmon collected from the St. Mary's River, Michigan (GLFHC 2012). Following elevated mortalities observed in Michigan in 2011, twenty cases of production and brood stock Atlantic salmon were tested for pathogens.* Aeromonas salmonicida *was detected in three of the twenty cases. However, analysis showed that furunculosis was not the cause of mortality (GLFHC 2012). Elsewhere in the Great Lakes region, seven of fourteen Pennsylvania state hatcheries tested positive for* A. salmonicida *in 2011 (GLFHC 2012).*
Although furunculosis is not reportable in the U.S, it is a reportable disease in Australia (DAFF 2011).

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6

Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

In salmonid hosts that contract furunculosis as a result of infection by A. salmonicida, *symptoms can include: furuncles, hemorrhaging, enlarged organs, erratic swimming, and lack of feeding (Cipriano and Bullock 2001, Crawford 2001). Because of this, infected fish may be more susceptible to predation (Lafferty and Morris 1996). However, cascading food web effects as a result of furunculosis infection in the Great Lakes have not been reported.*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Aeromonas salmonicida *is capable of transferring plasmids that confer drug resistance from one strain to another, which has the potential to result in new and more virulent strains of the disease evolving and appearing among salmonid populations (Bakke and Harris 1998).*

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Aeromonas *spp. are significant human pathogens causing extra-intestinal infections in various organs (von Graevenitz and Mensch 1968). However*, A. salmonicida *is a fish pathogen and has not been associated with human infection (Janda and Abbott 1996).*

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR	1 √

It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	
Not significantly	0
Unknown	U

Nationwide, infectious diseases cost the Canadian Aquaculture industry over $400 million annually with furunculosis accounting for approximately 10% in losses annually (Nash et al. 2006). The proportion of these losses specific to the Great Lakes region has not been reported.
The economic impact of pathogen screening requirements for the baitfish and aquaculture industries (see Management) are likely to be significant, but have not been documented.
Non-native Great Lakes wild and cultured salmonid populations susceptible to A. salmonicida *infection include coho salmon* (Oncorhynchus kisutch), *brown trout* (Salmo trutta), *chinook salmon* (O. tshawytscha), *and rainbow trout* (O. mykiss) *(GLFHC 2006, GLFHC 2012). Prevalence of* A. salmonicida *in these species is low to moderate and mortalities are rare.*
Atypical A. salmonicida *is introduced and common among goldfish in Australia (Humphrey and Ashburner 1993, Trust et al. 1980). There have been major epidemics of this bacterium in salmonid populations, particularly in fish farms and hatcheries in the United Kingdom, Norway, and on the west coast of North America in British Columbia and Washington State (Bakke and Harris 1998, Morrison 1995).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

<u>BENEFICIAL EFFECT</u>

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of	1

effectiveness	
Not significantly	0 √
Unknown	U

In lab environments, the A. salmonicida *bacterium can be pathogenic to zebra mussels* (Dreissena polymorpha). *In the wild, mussel populations may act mainly as reservoirs for* A. salmonicida, *and further research is necessary to understand the ecology of the interaction between these species (Gu and Mitchell 2002, Maki et al. 1998).*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact

>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Bothriocephalus acheilognathi*

Common Name: Asian tapeworm

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Historically, B. acheilognathi *has had a limited distribution in the Great Lakes—infecting several native species including fathead minnow* (Pimephales promelas), *bluntnose minnow* (P. notatus), *and golden shiner* (Notropis crysoleucas) (*Choudhury et al. 2006, Marcogliese 2008).*
Bothriocephalus acheilognathi *infects other U.S. species of importance including roundtail chub* (Gila robusta) *(Brouder 1999), the endangered bonytail chub* (G. elegans) *(Hansen et al. 2006), and the endangered humpback chub* (G. cypha) *(Choudhury et al. 2004, Hansen et al. 2006) and is listed as a "Pathogen of Regional Importance" in the southwestern U.S. (USFWS 2012).*
Bothriocephalus acheilognathi *displays a low degree of host specificity, and has been observed in 102 species in 14 families and 7 orders worldwide (Dove and Fletcher 2000, Maldonado 2003).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Parasitic nutrient competition may lead to reduced body condition and growth, anemia, and temperature-dependent mortality. Pathogenic effects include intestinal inflammation, protein depletion, and altered digestive enzyme activity (Marcogliese 2008). Because of this, infected fish are more susceptible to predation (Lafferty and Morris 1996). However, cascading food web effects have not been reported as a result of B. acheilognathi *infection in the Great Lakes.*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	

0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Tapeworm-parasitized fish are safe to consume, provided the fish are thoroughly cooked, smoked, or pickled (Alexander 2008).

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Golden shiner and fathead minnow are the most common commercially farmed baitfish in the United States (ODNR 2012).

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √

Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Common carp (Cyprinus carpio) *and grass carp* (Ctenopharyngodon idella) *are principle hosts for Asian tapeworm (Dove and Fletcher 2000), infection of which could lead to population reductions in those species.*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

<table>
<tr><th colspan="3">Scoring</th></tr>
<tr><td>Score</td><td># U</td><td>Impact</td></tr>
<tr><td>>5</td><td>Any</td><td>High</td></tr>
<tr><td>2-5</td><td>Any</td><td>Moderate</td></tr>
<tr><td>0</td><td>0-1</td><td rowspan="2"><u>Low</u></td></tr>
<tr><td>1</td><td>0</td></tr>
<tr><td>0</td><td>≥2</td><td rowspan="2">Unknown</td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

Scientific Name: *Dactylogyrus amphibothrium*

Common Name: Monogenetic gill fluke

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Dactylogyrus amphibothrium *displays host specificity for percids, particularly in the genus* Gymnocephalus *(Cone et al. 1994); however, outside its native region, it has also been recorded on cyprinids (Gibson et al. 1996, Kakacheva-Avramova 1977). Yellow perch* (Perca flavescens) *are potentially also at risk for infection by this monogenean parasite, although no such infection has yet been recorded (Cone et al. 1994).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual	1

level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe	1

AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring

Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

In the Great Lakes, D. amphibothrium *appears to be host specific to the introduced Eurasian ruffe* (Gymnocephalus cernua) *(Cone et al. 1994), infection of which could lead to population reductions. However, no such effects have yet been realized in the Great Lakes.*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √

Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

<table>
<tr><th colspan="3">Scoring</th></tr>
<tr><td>Score</td><td># U</td><td>Impact</td></tr>
<tr><td>>5</td><td>Any</td><td>High</td></tr>
<tr><td>2-5</td><td>Any</td><td>Moderate</td></tr>
<tr><td>0</td><td>0-1</td><td rowspan="2"><u>Low</u></td></tr>
<tr><td>1</td><td>0</td></tr>
<tr><td>0</td><td>≥2</td><td rowspan="2">Unknown</td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

Scientific Name: *Dactylogyrus hemiamphibothrium*

Common Name: a monogenetic fluke

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Dactylogyrus hemiamphibothrium *is a parasite of percids, particularly in the genus* Gymnocephalus *(U. S. Department of the Interior 1993); it has also been reported to parasitize the genus* Perca *(Gibson et al. 1996). Due to host specificity for Eurasian ruffe* (G. cernua) *in its native range*, D. hemiamphibothrium *is unlikely to exert negative impacts on native fish species in the Great Lakes (U.S. Department of the Interior 1993).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual	1

level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe	1

AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring

Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

In the Great Lakes, D. hemiamphibothrium *appears to be host specific to the introduced Eurasian ruffe* (Gymnocephalus cernua) *(U.S. Department of the Interior 1993), infection of which could lead to population reductions. However, no such effects have yet been realized in the Great Lakes.*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √

Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Dugesia polychroa*

Common Name: A flatworm

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Great Lakes native organisms consumed by Dugesia polychroa *include tubificids, gastropods, amphipods, and isopods (Boddington and Mettrick 1974).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Throughout much of its distribution in North America, D. polychroa *feeds primarily on oligochaetes (Boddington and Mettrick 1974), while the native* D. tigrina *are is believed to feed extensively on gastropods (Reynoldson 1974). However, in Toronto Harbour, Ontario,* D. polychroa *and* D. tigrina *are found to coexist; the latter is found at lower densities at each locality, suggesting potential intra-specific competition between the triclads (Boddington and Mettrick 1974).*
In Britain, competition for food resources, specifically gastropods, is observed between D. polychroa *and* D. tigrina *(Reynoldson and Davies 1970).*

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1

Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1 √
Not significantly	0
Unknown	U

Planarians have been used in medicinal and scientific research in topics including, but not limited to, genomics (Alvarado and Newark 1999), stem cells (Newark and Alvarado 2000, Reddien and Alvarado 2004), and cancer

(Oviedo et al. 2008), as well as for modeling morphogenesis, restoration of pattern and polarity, control of tissue proportions, and tissue homeostasis (Salo et al. 2009).

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: ***Glugea hertwigi***

Common Name: A microsporidian parasite

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

In the Great Lakes, G. hertwigi *exhibits host specificity for rainbow smelt (*Osmerus mordax*) (Muzzall and Whelan 2012), a species which competes with and feed on several important native and non-native species in the Great Lakes food web.* Glugea hertwigi *is known to damage the mesentery, intestinal organs, and gonads in rainbow smelt. Such parasitism by* G. hertwigi *can be lethal or non-lethal (Pekcan-Hekim et al. 2005). Infections in the stomach and intestine can cause starvation and intestinal poisoning (Chen and Power 1972, Delisle 1972, Mills et al. 1993, Pekcan-Hekim et al. 2005, Scarborough and Weidner 1979). Die-offs of rainbow smelt as a result of* G. hertwigi *infection have the potential to indirectly cause significant (generally beneficial) cascading food web effects in the Great Lakes (see Beneficial Effects).*

Great Lakes native Atlantic salmon, lake trout, and other salmonids are known to prey heavily upon rainbow smelt (EPA 2008). Osmerus mordax *is believed to have aided the growth of landlocked Atlantic salmon in Maine (Havey 1973). Die-offs of O. mordax as a result of G. hertwigi could have adverse health effects on Great Lakes salmonids. Furthermore, while there is no evidence of native coregonid infection in the Great Lakes, G. hertwigi is known to parasitize Coregonus species in northern Russian lakes (Dykova 1995).*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	

0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Glugea hertwigi *has been implicated in mass mortalities of rainbow smelt (*O. mordax*; see GLANSIS rainbow smelt fact sheet) in Lake Erie (Nepszy and Dechtiar 1972, Nepszy et al. 1978) and Lake Ontario (A. Dechtiar, unpublished data). Mortality events are believed to be seasonal and directly related to parasite prevalence (Dechtiar and Nepszy 1988).* Glugea hertwigi *cysts in ovaries of mature rainbow smelt females have also caused greatly reduced egg production (Chen and Power 1972). However, it should be noted that the presence of* G. hertwigi *in rainbow smelt in other dieoff events had no significant effect on fecundity or condition, although it did cause growth to slow somewhat (Nsembukya-Katuramu et al. 1981). While economic impacts of* G. hertwigi *on the commercial smelt (see Pflieger 1997, Smith 1985) and salmonid (which rely on smelt) fisheries have not been realized, significant impacts could be realized if rainbow smelt mortalities were to increase as a result of infection.*
In Ontario waters of Lake Erie, G. hertwigi *has been isolated at prevalences between 36 and 90%, historically (58% between 1961-1969, Dechtiar 1972a; 63% between 1968-1969, Chen and Power 1972; 90% in 1969, Nepszy et al.*

1978; 36-78% between 1976-1977, Nsembukya-Katuramu et al. 1981). Additional prevalences of this parasite within Lake Erie fall within this range (55% prevalence with ≥ 50 parasites/host between 1970-1975, Dechtiar and Nepszy 1988; 88% in the western and west central basins in 1971, Nepszy and Dechtiar 1972). Glugea hertwigi *poses the largest threat (e.g., high infection rates and mortalities) to Lake Erie rainbow smelt populations as compared to any other microsporidian (Muzzall and Whelan 2012).*
In Lake Ontario, G. hertwigi *has been isolated at 5% prevalence (between 1968-1969; Chen and Power 1972) and 23% prevalence with heavy infections (from 1961-1971; Dechtiar and Christie 1988). Another occurrence was recorded in Port Ontario, NY; however, prevalence and intensity were unknown (Ehlinger 1966).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1

Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

*As rainbow smelt preys heavily upon bloater (*Coregonus hoyi*), alewife (*Alosa pseudoharegus*), slimy sculpin (*Cottus cognatus*), emerald shiner (*Notropis atherinoides*), burbot (*Lota lota*), and opossum shrimp (*Mysis relicta*) (Brandt and Madon 1986, Creaser 1925, O' Gorman 1974, Stedman and Argyle 1985, Van Oosten 1940), its diet is believed to affect prey population numbers and can be an important component to the total mortality of yearlings (Creaser 1925, O' Gorman 1974). Furthermore, commercially valuable native and non-native salmonids rely on several of these prey species (e.g., bloater, alewife, emerald shiner). Die-offs of rainbow smelt as a result of* G. hertwigi *may increase prey fish populations, thus increasing feeding opportunities and improving the health and value of the salmonid fisheries. However, such effects have not been realized in the Great Lakes.*

*Additional potential food web effects include those on lake trout (*Salvelinus namaycush*). Juvenile lake trout tend to eat slimy sculpin, while adults consume rainbow smelt (Brandt and Madon 1986). Direct competition for slimy sculpin between juvenile lake trout and rainbow smelt has been observed (Brandt and Madon 1986). Lake trout may therefore be a keystone predator in the relationship between rainbow smelt and slimy sculpin (Brandt and Madon 1986). Mortalities in rainbow smelt by* G. hertwigi *could decrease competition and stress in juvenile lake trout and could have significant beneficial effects on the Great Lakes food web.*

*Furthermore, rainbow smelt compete with lake herring (*Coregonus artedii*) and yellow perch (*Perca flavescens*) and may be partially responsible for the decline of Great Lakes whitefish (Coregonus spp.) (Becker 1983, Christie 1974, Hrabik et al. 1998, Todd 1986). Increased* G. hertwigi *infections and die-offs of rainbow smelt could lead to a* *decrease in competition and stress on lake herring and yellow perch and may increase the commercially valuable whitefish population.*

*Lastly, rainbow smelt contributed to the extinction of blue pike (*Sander vitreus glaucus*), a species prevalent in the Great Lakes until the 1980s. Rainbow smelt have also affected imperiled species outside the Great Lakes (EPA 2008). Because of competition between rainbow smelt and native species, and* O. mordax *diet, other imperiled species in the Great Lakes could experience similar effects.*

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Heterosporis sp.*

Common Name: Microsporidian

Environmental: High
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6 √
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

This particular species of Heterosporis has been isolated from several native Great Lakes species including walleye (Sander vitreus), *northern pike* (Esox lucius), *burbot* (Lota lota), *mottled sculpin* (Cottus bairdi), *slimy sculpin* (C. cognatus), *pumpkinseed* (Lepomis gibbosus*), and yellow perch* (Perca flavensis). *Yellow perch is the only species in which impacts have been realized (GLFHC 2012, IDNR 2005, Sutherland 2002, Sutherland et al. 2004). Prevalence of this parasite in Great Lakes yellow perch can range between 5% and 30%, with the majority of infections at 20% (Sutherland 2002). However, because of the wide range of Great Lakes native species susceptible to both infections (see Socio-Economic Impacts) this species is assessed as having a high environmental impact in this region. Laboratory-based infections of* Heterosporis *sp. have been observed in Great Lakes native species including channel catfish* (Ictalurus punctatus), *bluegill* (Lepomis macrochirus), *and white sucker* (Catostomus commersonii); *the latter two species are less susceptible and experience much less muscle damage than the catfish (GLFHC 2012, IDNR 2005, Sutherland 2002, Sutherland et al. 2004).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1 √
Not significantly	0

Unknown	U

Declines to the Great Lakes yellow perch stocks are believed to stress predator-prey relationships. There is no evidence to show this parasite causes fish mortality directly, but the destruction of muscle in infected fish increases susceptibility to predation (Goodwin 2008, Sutherland 2002).

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	7
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	**<u>High</u>**
2-5	Any	Moderate
0	0-1	Low
1	0	

0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Lake Ontario commercial fisheries are concerned about the economic impacts of Heterosporis *sp. as infected fish suffer a significant loss of muscle tissue and are not marketable (i.e. must be discarded) (Sutherland 2002). Sutherland (2002) has also expressed concern that the presence of* Heterosporis *sp. in Lake Michigan may significantly impede the recovery of depressed yellow perch stocks, which have experienced population declines in Lake Michigan over the past decade. Economic impacts to the yellow perch fisheries could be realized if this parasite becomes established there.*

Laboratory-based infections of Heterosporis *sp. have been observed in commercially valuable Great Lakes native species including brook trout* (Salvelinus fontinalis), *lake trout* (S. namaycush), *fathead minnow* (Pimephales promelas), *and largemouth bass* (Micropterus salmoides), and *valuable non-native species including Coho salmon* (Oncorhynchus kisutch), *rainbow trout* (Oncorhynchus mykiss), *and brown trout* (Salmo trutta). *The trout and minnow species are highly susceptible to infection, while the bass and salmon are marginally susceptible and*

experience much less muscle damage if infected at all (Sutherland 2002, Sutherland et al. 2004). Economic impacts to wild and cultured populations could be realized if natural infections are observed.
Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

While there have been no field observation of biological control of nonnative species in the Great Lakes, common carp (Cyprinus carpio) *and goldfish* (Carassius auratus) *appear to be highly susceptible to infection by* Heterosporis *sp. based on laboratory experiments (Sutherland 2002, Sutherland et al. 2004).*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Ichthyocotylurus pileatus*

Common Name: A digenean fluke

Environmental: High
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6 √
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

In the Great Lakes, larval or immature I. pileatus *have been detected in yellow perch* (P. flavescens) *at 37.7% prevalence (582 fish examined) with light (1-9 parasites/host) to moderate (10-49 parasites/host) infections (Dechtiar and Lawrie 1988, Dechtiar and Nepszy 1988, Muzzall and Whelan 2011); walleye* (S. vitreus) *at 47% prevalence (15 fish examined) with moderate infections (Dechtiar and Lawrie 1988); and trout-perch* (P. omiscomaycus) *(Bangham and Hunter 1939) at 54% prevalence (39 fish examined) with light infections (Dechtiar and Lawrie 1988, Dechtiar and Nepszy 1988). The larval form of* I. pileatus *is also found in piscivorous birds of Lake Superior and the Lake St. Clair System (Muzzall and Whelan 2011).*

While not documented for this species in the Great Lakes, adult digenean parasites tend not to severely impact their definitive host; infection of first and second hosts may result in castration (due to invasion of host gonads) and decreased fitness (due to diversion of host energy to parasite nutrition), respectively (Bartoli and Boudouresque 2007). Ichthyocotylurus pileatus *has the potential to be pathogenic to fish, particularly young individuals, when intensities of larvae/immature parasites are high (Muzzall and Whelan 2011).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √

Unknown	U

Digenean flukes can cause pathological effects and mortality in juvenile and adult fishes (Bychovaskaya-Pavlovskaya and Petrushevski 1963, Dukes 1975). Because of altered behavior, infected fish may be more susceptible to predation (Lafferty and Morris 1996). However, cascading food web effects have not been reported as a result of I. pileatus *infection in the Great Lakes.*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	6
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	Low

0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Recreationally valuable Great Lakes species susceptible to I. pileatus *infections include yellow perch, walleye, and trout-perch; however, impacts to this sector have not been realized.*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Non-native Great Lakes species found harboring larval or immature I. pileatus *include Eurasian ruffe* (Gymnocephalus cernuaus*) (Pronin et al. 1998) and round goby* (Neogobius melanostomus) *(Pronin et al. 1997b).* Ichthyocotylurus pileatus *is unlikely to have significant effects in terms of regulating the round goby population in the Great Lakes (Pronin et al. 1997b). It is possible, however, that its presence in combination with that of other more prevalent parasites in Eurasian ruffe increases this species' susceptibility to the negative effects of anoxia (Pronin et al. 1997a).*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Myxobolus cerebralis*

Common Name: Myxosporean parasite, salmonid whirling disease

Environmental: High
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6 √
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

Multiple salmonids are susceptible to infection by M. cerebralis*, but the degree of susceptibility as well as symptom expression varies among species. Great Lakes native salmonid species susceptible to the pathogen include Atlantic salmon (*Salmo salar*), brook trout (*S. fontinalis*), cutthroat trout (*Oncorhynchus clarki*), and bull trout (*Salvelinus confluentus*). In contrast, lake trout (*S. namaycush*) is not susceptible to infection (Bartholomew et al. 2003, Blazer et al. 2004, Gilbert and Granath 2003, Krueger et al. 2006, Sollid et al. 2003).*
Historically, the realized environmental impacts of whirling disease on native Great Lakes aquacultured and wild species have been low (GLFHC 2006, GLFHC 2012). However, while M. cerebralis *has not been detected in the Great Lakes region of Canada, the Canadian Food Inspection Agency (2012) lists it as a reportable disease. Such recognition warrants assessment of this species as having a high environmental effect for the region.*
Myxobolus cerebralis *myxospores infect the cosmopolitan oligochaete worm* Tubifex tubifex *prior to development into a fish-infecting form (Elwell et al. 2009). Infection of* T. tubifex *can negatively affect the host's growth, reproduction, and survival (DuBey et al. 2005, El-Matbouli and Hoffmann 1998, Gilbert and Granath 2003, Hedrick and El-Matbouli 2002, Stevens et al. 2001). However, such an impact on Great Lakes* T. tubifex *populations has not been reported (possibly due to a lack of research in this area).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR	1

Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	
Not significantly	0 √
Unknown	U

Whirling disease can result in whirling behavior or tail-chasing; damage to the central nervous system and organs of equilibrium; lesions in the skull, gills, and vertebrae; and sometimes mortality (Crawford 2001, Gilbert and Granath 2003, Krueger et al. 2006, Mills et al. 1993). This causes stress and leads to reduction in fish populations by making it difficult for individuals to effectively escape predators or feed (WDI 2011). However, cascading food web effects as a result of M. cerebralis *infection have not been reported in the Great Lakes.*

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Whirling disease can alter fish community composition by replacing susceptible species with more resistant species such as brown trout (Elwell et al. 2009). This has been observed in several Montana drainages, where rainbow trout populations decreased while brown trout increased (Baldwin et al. 1998).

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	7
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	**<u>High</u>**
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

<u>SOCIO-ECONOMIC IMPACT</u>

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Whirling disease has no known human health effects (WDI 2006).

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

The consequences of identifying this parasite in a hatchery can be severe, including facility closure, expensive renovations, and destruction of infected stock, leading to high economic costs. At a national level, trout fisheries—

including the $325 million U.S. hatchery-raised rainbow trout industry (economic benefit reported 2004; USFWS 2006) that generated annual sales of more than $80 million from 2005-2007 (USDA 2008)—are especially at risk. In 2007, 86 percent of the United States' 34.3 million trout intended for sale were lost due to a variety of diseases (USDA 2008). This percentage of state and federally raised hatchery trout intended for market but lost to disease rose to 90 percent in 2009 (USDA 2010). Furthermore, economic impacts realized at a regional level outside the Great Lakes as a result of M. cerebralis infection include a nearly 29 percent reduction in the total value of trout sales and the closure of six private hatcheries in Utah in 2005 (Stromberg 2006).

In 2006, low level infections of M. cerebralis *spores were detected in rainbow trout reared in a Pennsylvania state hatchery. Whirling disease spores were also isolated from Pennsylvania's Lake Erie steelhead in 1989, 1991, and 1997 (GLFHC 2006). However, wild trout populations of the mid-Atlantic region have not experienced observable declines, despite the presence of* M. cerebralis *and susceptible species (Hulbert 2005, Kaeser et al. 2006, Kaeser and Sharpe 2006).*

In spring 2011, Michigan authorities conducted pre-stocking testing for M. cerebralis *on nine representative lots of hatchery fish (60 fish per lot, including brown trout, rainbow trout, chinook salmon, Atlantic salmon, coho salmon, lake trout, brook trout, splake, and lake herring), and all were found negative for the parasite (GLFHC 2012). However, when conducting the same tests on wild-caught fish from hatchery water sources, molecular evidence of* M. cerebralis *was detected in one sample (containing pooled tissue of a total of 60 brown and rainbow trout from three sources— Slagle Creek, Harrietta Effluent Pond, and Brundage Spring Pond (GLFHC 2012).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

The multibillion dollar per year Great Lakes sport fishery and the multimillion dollar per year inland trout fishing industry are at risk if whirling disease becomes established in Wisconsin and Minnesota and/or continues to infect hatcheries and wild populations in Michigan (Frank 2002).

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring

Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Neascus brevicaudatus*

Common Name: A digenean fluke

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

The only occurrence of N. brevicaudatus *in the Great Lakes has been from the introduced Eurasian ruffe (*G. cernua*) at 5% prevalence with very light (<1 parasite/host) infections (Pronin et al. 1998). Due to the slow rate of population growth and expansion of* N. brevicaudatus*, its impacts in the Great Lakes are believed to be negligible (Pronin et al. 1998). Larvae of this species mature in piscivorous birds (Muzzall and Whelan 2011); however, the effects of such infections have not been studied.*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6

Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6

Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Neascus brevicaudatus *is believed to be unlikely to help regulate populations of the introduced Eurasian ruffe (U.S. Department of the Interior 1993).*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √

Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: Viral hemorrhagic septocemia Virus (Family Novirhabdoviridae, Order Mononegavirales) Genotype IV sublineage b

Common Name: Viral Hemorrhagic Septicemia (VHSV-IVb)

Environmental: High
Socio-Economic: High
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6 √
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

VHS is listed as a World Organization for Animal Health (OIE) reportable disease for aquatic animals (OIE 2012). VHS is believed to have caused large die-offs of freshwater drum (Aplodinotus grunniens) *in eastern Lake Ontario and muskellunge (*Esox masquinongy) *in Lake St. Clair in 2005 (Wren and Lee 2006). In the spring and summer of 2006, VHS was implicated as a cause of large die-offs of muskellunge in the Thousands Islands area of the St. Lawrence River (Wren and Lee 2006) and die-offs of muskellunge, northern pike* (Esox lucius), *gizzard shad* (Dorosoma cepedianum), *smallmouth bass* (Micropterus dolomieui), *walleye* (Sander vitreus), *and yellow perch* (Perca flavescens) *in Lakes St. Clair, Erie, and Ontario (USDA and APHIS 2006). Die-offs of walleye in Conesus Lake, NY and lake whitefish* (Coregonus clupeaformis) *and walleye in Thunder Bay in the fall of 2006 were also believed to have been caused by VHS (Whelan 2009). In May 2007, low to moderate fish kills of freshwater drum were experienced in the Wisconsin lakes Butte des Mortes and Winnebago. Later that year, there was a die-off of sunfish (Family Centrarchidae) in the Seneca-Cayuga Canal, New York (Focus on Fish Health 2010). VHS has also been implicated as the cause of lake whitefish and walleye die-offs in Lake Huron (MSG 2012).*
Other Great Lakes native species that are susceptible to VHS and have experienced mild to moderate die-offs include black crappie (Pomoxis nigromaculatus) *and bluegill* (Lepomis macrochirus) *in Budd Lake, MI and Lake St. Clair, white bass* (Morone chrysops) *in Lake Erie, and rock bass* (Ambloplites rupestris*) in Skaneateles Lake, NY (Whelan 2009). Die-offs of largemouth bass* (Micropterus salmoides) *have also been observed (Kim and Faisal 2010a, Kim and Faisal 2010b).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any	6

native species populations, creation of a dead end or any other significant alteration in the food web)	
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1 √
Not significantly	0
Unknown	U

VHS has the potential to infect a wide range of fish species (Kim and Faisal 2010a) with clinical signs such as body twisting and erratic swimming (CFSPH 2003). Because of this, infected fish may be more susceptible to predation (Lafferty and Morris 1996), which could result in indirect effects on the food web and ecosystem. Die-offs of apex predators such as muskellunge and northern pike may have severe impacts on the Great Lakes food web.

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	7
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	<u>**High**</u>
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

<u>SOCIO-ECONOMIC IMPACT</u>

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Humans are not susceptible to VHS and there is no evidence that the virus can be transferred to humans by consuming infected fish (PFBC 2011).

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6 √
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

Increased regulations have limited the scope of operations for those in the bait/live fish industry and have cost a substantial amount of additional time and money to fulfill testing and certification requirements.
Despite the wide host range of the virus, effects on commercial and recreational fisheries related to die-offs have been relatively mild in the Great Lakes (Focus on Fish Health 2010).
As of June 2011, there has not been a recorded outbreak of VHS within a hatchery system in the United States. Under APHIS policy, total destruction and disinfection of a hatchery is likely if VHS is isolated, leading to significant economic loss (PFBC 2011).

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1 √
Not significantly	0
Unknown	U

While many commercially and recreationally-valuable salmonids— including chinook salmon (Oncorhynchus tshawytscha*), coho salmon* (O. kisutch), *and rainbow trout* (O. mykiss)*—are susceptible to the Great Lakes strain of the virus (IVb), recent studies indicate they experience VHS-induced symptoms and mortality less often than other susceptible species (Al-Hussinee et al. 2010, Kim and Faisal 2010a). Recreationally-valuable species that have been particularly affected experimentally include muskellunge* (E. masquinongy*) and largemouth bass* (M. salmoides), *both of which have experienced very high mortality rates (Kim and Faisal 2010a, Kim and Faisal 2010b).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	7
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	Low
0	≥2	Unknown
1	≥1	Unknown

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

VHS has caused die-offs of non-native species in the Great Lakes, including round goby (Neogobius melanostomus) *(Wren and Lee 2006). In 2008, the first recorded die-off of round goby occurred in Lake Michigan, although observed signs of the virus had been documented in Lake Michigan in 2007 (Focus on Fish Health 2010). Die-offs of common carp* (Cyprinus carpio) *have been observed in Lake Ontario (Whelan 2009).*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate

<table>
<tr><td>0</td><td>0-1</td><td rowspan="2"><u>Low</u></td></tr>
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<tr><td>0</td><td>≥2</td><td rowspan="2">Unknown</td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

Scientific Name: *Piscirickettsia cf. salmonis*

Common Name: Muskie pox

Environmental: Moderate
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Piscirickettsia cf. salmonis *infections have been limited in the Great Lakes to muskellunge* (E. masquinongy) *and yellow perch* (Perca flavescens) *from Lake St. Clair (Hartig 2006, Thomas and Faisal 2009, MDNR 2004). The bacterium was detected in all of the fish (n=26) sampled from Lake St. Clair during a large muskellunge die-off in 2003. No subsequent mortalities were observed in St. Clair until 2006 (Hartig 2006, Thomas and Faisal 2009).* Piscirickettsia cf. salmonis *infection rates in Lake St. Clair muskie have been found to be over 80 percent in fish larger than 1,000 mm and or individuals older than 8 yrs (2004-2007; Thomas and Faisal 2009).* Piscirickettsia cf. salmonis *has also been isolated from yellow perch* (P. flavescens) *from St. Clair with infection rates as high as 57 percent. Analysis of the two isolates from muskellunge and yellow perch indicate both are identical (Thomas and Faisal 2009). However, surveys of* P.cf. *salmonis infected waters in the Great Lakes do not indicate substantial negative impacts on native fish populations (MDNR 2004, WDNR 2012).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1 √
Not significantly	0
Unknown	U

Piscirickettsia cf. salmonis *infections can result in anemia, kidney necrosis, an enlarged spleen, hemorrhaging, nodules or crater-form lesions in the liver, skin lesions, anorexia, and lethargy (Fryer and Hedrick 2003, Mauel and Miller 2002, Rise et al. 2004). Because of altered behavior, infected fish are more susceptible to predation (Lafferty and Morris 1996), which could result in indirect effects on the food web and ecosystem. Die-offs of apex predators such as muskellunge is likely to impact the Great Lakes food web, although such effects have not yet been reported as a result of* P. salmonis *infection*.

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	2
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	**Moderate**
0	0-1	Low

1	0	
0	≥2	Unknown
1	≥1	

<u>SOCIO-ECONOMIC IMPACT</u>

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

Piscirickettsia cf. salmonis *infections in cultured Atlantic salmon (Salmo solar) from the Pacific and Atlantic coasts of Canada have led to population mortality levels of 0.6-15% (Evelyn 1992, Olsen et al. 1993, Rodger and Drinan 1993). However, no such infections have been realized in Great Lakes Atlantic salmon. Atlantic salmon are considered less susceptible to infection and mortality; in contrast, coho salmon* (Oncorhynchus kisutch), *rainbow trout* (O. mykiss), *and Chinook salmon* (O. tschwaytscha) *are more susceptible (Birkbeck et al. 2004, Fryer and Hedrick 2003, Mauel and Fryer 2001, Mauel and Miller 2002, Rise et al. 2004). Infections in non-native salmonids have not been realized in the Great Lakes.*

Chilean aquaculture facilities have experienced mortality due to P.cf. salmonis *in 30-90% of reared coho salmon (Bravo and Campos 1989). As a result, this industry has shifted their cultures to Atlantic salmon (Reid et al. 2004). If similar effects are realized in the Great Lakes, significant economic impacts could be realized.*

While impacts to the sport fishing industry by P.cf. salmonis *have not yet been realized, such effects could be significant. For example, recreational fishing on Lake St. Clair can generate $23 million annually (Thomas and Faisal 2009).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Surveys of P. cf. salmonis *infected waters in the Great Lakes do not indicate substantial negative impacts on native fish populations (MDNR 2004, WDNR 2012).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

<u>BENEFICIAL EFFECT</u>

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Ranavirus sp.*

Common Name: Largemouth bass virus (LMBV)

Environmental: High
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6 √
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

As Ranavirus *sp. has resulted in the reduction of native largemouth bass (*Micropterus salmoides*) populations, this virus is assessed as having a high environmental impact in the Great Lakes. Further research is needed to determine if a developing immunity similar to the populations seen in Florida is realized in Great Lakes largemouth bass populations.*

In Michigan, LMBV mortality events typically have involved 100-500 fish or 10 percent of the population per lake (Grizzle and Brunner 2003, Whelan 2004). However, Ranavirus *sp. has also been implicated in several more significant largemouth bass die-offs within the Great Lakes basin, including in Lake George, Indiana—where LMBV was detected in 90% of fish sampled (Grizzle and Brunner 2003, Whelan 2004)—and in a small Steuben County, Indiana lake (2011; Sarvay 2012). The latter resulted in the death of 50 percent of the lake's largemouth bass population (Sarvay 2012).*

Prevalence of Ranavirus *sp. in the state of Michigan was determined using 2000-2003 virus survey data. When detected (15 of 30 surveyed lakes), prevalence at the other lakes ranged from 6.3% (Lake Orion) to 100% (Lake St. Clair, Sanford Lake, Woodland Lake), with detection of the LMBV in close to or more than half of the largemouth bass sampled from many of these lakes (Whelan 2004). However, levels of fish infection varied among sites and between sample years. For example, the virus was detected in Lake Orion at 6.3% prevalence in 2002 and then at 48% in 2003. In Woodland Lake,* Ranavirus *sp. was detected at 100% prevalence in 2002 and at 60% in 2003. The virus was also detected in Lake George at 90% prevalence in 2000 and 0% prevalence in 2002 (Whelan 2004). This may suggest the virus enters a water body, infects the population until a peak infection rate is observed, and then prevalence decreases.*

Other Great Lakes native species susceptible to infection by Ranavirus *sp. include smallmouth bass (*M. dolomieui*), bluegill (*Lepomis macrochirus*), crappie (*Pomoxis *spp.), and chain pickerel (*Esox niger*). However, mortality events attributed to LMBV are rare in these species (Goldberg 2002, Grizzle and Brunner 2003, Grizzle et al. 2003, Whelan 2004, Woodland et al. 2002).*

Ranavirus *sp. was implicated in the die-off of over 1,000 and 3,000 largemouth bass in South Carolina and a northern Mississippi drainage reservoir, respectively (Bister et al. 2006, Hanson et al. 2001, Plumb et al. 1996). In 2010, LMBV was detected in 40 percent of the largemouth bass in Kerr Reservoir and Buggs Lake, Virginia. Small die-offs also occurred in Briery Creek Lake and Sandy River Reservoir, Virginia. However, no significant impacts to the fisheries were realized (VDNR 2011). Die-offs have also occurred in Alabama, Georgia, Louisiana, Mississippi, and Texas (Bister et al. 2006). Moreover, since 1995, over 25 fish kills throughout the southeast and Midwestern U.S. have been linked to LMBV (FFWCC 2012).*

Initial exposure to LMBV elicits antibody production, resulting in less severe disease manifestation in subsequent exposures (e.g., FFWCC 2012, Goldberg 2002, Grizzle and Brunner 2003, Grizzle et al. 2003, Hodge 2004, Whelan

2004, Woodland et al. 2002). For example, in Florida, largemouth bass die-offs associated with LMBV have declined since first detection and no known die-offs have been observed since 2010 (FFWCC 2012).

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Symptoms of LMBV can include lethargy, decreased responsiveness, swimming at the surface and or in circles, and difficulty remaining upright (Beck et al. 2006, Goldberg 2002, Grizzle and Brunner 2003, Zilberg et al. 2000). Because of this altered behavior, infected fish may be more susceptible to predation (Lafferty and Morris 1996). However, cascading food web effects have not been reported as a result of LMBV infection in the Great Lakes.

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	6
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Largemouth bass virus poses no threat to human health (MAF 2008).

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR	1

It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Largemouth bass sport fishing organizations (e.g., Bass Anglers Sportfishing Society/BASS) have increased spending and time to evaluate and understand the impacts of LMBV on trophy-sized bass fisheries (Grizzle and Brunner 2003, Neal et al. 2009, Terre et al. 2008, Whelan 2004).

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1

Not significantly	0 √
Unknown	U

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**

<table>
<tr><td>1</td><td>0</td><td></td></tr>
<tr><td>0</td><td>≥2</td><td rowspan="2">Unknown</td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

Scientific Name: *Renibacterium salmoninarum*

Common Name: Bacterial kidney disease (BKD)

Environmental: High
Socio-Economic: High
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6 √
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

Great Lakes native salmonid species that have tested positive for the bacterium include Atlantic salmon (Salmo salar*), lake trout* (Salvelinus namaycush), *brook trout* (S. fontinalis), *and splake* (S. fontinalis x S. namaycush) *(GLFHC 2006, GLFHC 2012, Hay 2003, Jonas et al. 2002, Nuhfer et al. 2005, Starliper et al. 1997). Lake trout and brook trout are considered less susceptible to* R. salmoninarum *infection and may not experience mortality upon contracting BKD; in contrast, Atlantic salmon are more susceptible and prone to mortality (Hay 2003, Jonas et al. 2002, Nuhfer et al. 2005, Starliper et al. 1997).*
Other Great Lakes native species found harboring R. salmoninarum *include lake whitefish* (Coregonus clupeaformis), *bloater* (C. hoyi), *lake herring* (C. artedi), *mottled sculpin* (Cottus bairdi), *white sucker* (Catostomus commersonii), *muskellunge* (Esox masquinongy), *channel catfish* (Ictalurus punctatus), *lake sturgeon* (Acipenser fulvescens), *and walleye* (Sander vitreus*) (COSEWIC 2005, GLFHC 2006, GLFHC 2012, Hay 2003, Jonas et al. 2002, Nuhfer et al. 2005, Starliper et al. 1997). Four of the Great Lakes native species (splake, muskie, channel catfish, and lake sturgeon) represent new detections since 2005. Lake whitefish and bloater are believed to be less susceptible to* R. salmoninarum *infection and may not experience mortality upon contracting BKD (Hay 2003, Jonas et al. 2002, Nuhfer et al. 2005, Starliper et al. 1997). However, strains of the bacterium isolated from Lake Michigan have been found to be more virulent than those from the Pacific Northwest (Austin and Austin 1987, Grayson et al. 1999, Jonas et al. 2002, Starliper et al. 1997, Thomas et al. 1999) and in some cases have resulted in higher than anticipated levels of infection (e.g., Nalepa et al. 2005).*
While R. salmoninarum *affects multiple Great Lakes native species, as of 2006, prevalence and mortalities in infected fish had been relatively low (GLFHC 2006). However, more recent data from 2011 indicates that this bacterium has become more widely distributed with varying prevalence throughout Michigan state hatcheries and wild populations. The bacterium was detected in brook trout at 1.7% to 54% prevalence; Atlantic salmon 1.7% to 50%; muskellunge, lake sturgeon, and channel catfish at 1.7% to 10%; and lake trout, splake, and lake herring at 1.7%-5% prevalence (GLFHC 2012). That same year,* R. salmoninarum *was detected at low prevalence in Minnesota hatcheries and for the first time in lake trout from Mountain Lake, MN. The Minnesota Department of Natural Resources is considering whether or not to continue using that lake as a brood stock source (GLFHC 2012).*
Renibacterium salmoninarum *is considered to be endemic in Ontario and is found in OMNR fish culture facilities at low levels (GLFHC 2012).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Symptoms of BKD include abdominal fluid build-up and swelling, pseudomembranes and hemorrhaging on viscera, kidney and gill necrosis, intestinal hemorrhaging, ulcers or abscesses in muscles, protruding eyeballs, anemia, blood blisters, and lesions of the eyes, liver, spleen, and heart (Austin and Austin 1987, Holey et al. 1998). Because of this, infected fish may be more susceptible to predation (Lafferty and Morris 1996). However, cascading food web effects as a result of BKD infection in the Great Lakes have not been reported.

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse	1

effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Environmental Impact Total	6
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	**<u>High</u>**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

<u>SOCIO-ECONOMIC IMPACT</u>

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6 √
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

Lake whitefish (C. clupeaformis) *collected from Lake Michigan and Lake Huron between 2003 and 2006 tested positive for* R. salmoninarum *at 62.31% prevalence. Lake whitefish have a high commercial value in the Great Lakes (Nalepa et al. 2005), and if as a result of BKD infection, populations were to fluctuate significantly, there could be serious economic effects.*

Great Lakes non-native species that have tested positive for R. salmoninarum *include Chinook salmon* (Oncorhynchus tshawytscha) *(Holey et al. 1998), coho salmon* (O. kisutch*), rainbow trout* (O. mykiss*), and sea lamprey (*Petromyzon marinus) *(Eissa et al. 2006, Jonas et al. 2002). Rainbow trout* (O. mykiss) *is less susceptible to BKD infection and may not experience mortality upon contracting the disease, whereas coho salmon* (O. kisutch) *and Chinook salmon (*O. tshawytscha) *are more susceptible to infection and more prone to mortality (Hay 2003, Jonas et al. 2002, Nuhfer et al. 2005, Starliper et al. 1997).*

Prevalence rates of R. salmoninarum *were up to 100% in some parts of the Lake Michigan drainage around 1986. This outbreak of BKD caused heavy mortality in Chinook salmon in 1988 and persisted in the population until 1992. That year, boat fisheries observed at least a 40% decline in Chinook salmon catch per unit effort levels. By 1993, catch per unit effort was 15% of the peak observed in 1986 (Holey et al. 1998). In 1986, the Strawberry Creek spawning weirs in Wisconsin documented no presence of* R. salmoninarum. *In 1988, the bacterium was isolated in 67% of the returning Chinook salmon and then persisted at moderate levels through 1992 (Holey et al. 1998). The 1980s' mortality events are believed to have also been influenced by increased vulnerability due to food shortages, particularly alewives* (Alosa pseudoharengus), *high Chinook salmon density, and high parasite loads (Holey et al. 1998). While significant for the fisheries at that time, given the magnitude of the stocks present in Lake Michigan, it is improbable that the Chinook salmon die-offs observed in the late 1980s and early 1990s caused a residual demographic bottleneck in those populations (Weeder et al. 2005).*

As of 2006, the overall prevalence of R. salmoninarum *in non-native Great Lakes species was thought to be low and declining over time (GLFHC 2006, Jonas et al. 2002). However in 2011,* R. salmoninarum *was widely distributed with varying prevalence throughout Michigan state hatcheries and wild populations. The bacterium was detected in brown trout* (Salmo trutta) *at 1.7% to 54% prevalence, rainbow trout at 1.7% to 40%, coho salmon at 1.7% to 10%, and Chinook salmon at 1.7% to 5% prevalence (GFLHC 2012).* Renibacterium salmoninarum *was detected in 11 of 12 production lots of rainbow trout and coho salmon from 4 of 5 Indiana state hatcheries with prevalence ranging from 1.67% to 26.67%, with six cases exceeding 10% (GLFHC 2012).*

Bloater (C. hoyi) *is a staple of Great Lakes native and non-native salmonid diets. Reductions in salmonid populations and economic effects to the Great Lakes fishing industry could be realized if bloater populations decline (Wyns 2002).*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6 √
Yes, but negative consequences have been small	1
Not significantly	0
Unknown	U

Prevalence rates of R. salmoninarum *were up to 100% in some parts of the Lake Michigan drainage around 1986. This outbreak of BKD caused heavy mortality in Chinook salmon in 1988 and persisted in the population until 1992. That year, boat fisheries observed at least a 40% decline in Chinook salmon catch per unit effort levels. By 1993, catch per unit effort was 15% of the peak observed in 1986 (Holey et al. 1998). In 1986, the Strawberry Creek spawning weirs in Wisconsin documented no presence of* R. salmoninarum. *In 1988, the bacterium was isolated in 67% of the returning Chinook salmon and then persisted at moderate levels through 1992 (Holey et al. 1998). The 1980s' mortality events are believed to have also been influenced by increased vulnerability due to food shortages, particularly alewives* (Alosa pseudoharengus*), high Chinook salmon density, and high parasite loads (Holey et al. 1998).*

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	12
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	**High**
2-5	Any	Moderate
0	0-1	Low
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

In addition to commercially valuable non-native Great Lakes species (see Socio-economic Impacts), sea lamprey (Petromyzon marinus) *has tested positive for BKD (Eissa et al. 2006). However, infection is not likely to control sea lamprey populations.*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6

It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Rhabdovirus carpio*

Common Name: Spring viraemia of carp (SVCv)

Environmental: High
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6 √
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0
Unknown	U

SVC is listed as a World Organization for Animal Health (OIE) reportable disease for aquatic animals (OIE 2012) and is also listed as a reportable disease in Canada (CFIA 2012). As such, it is automatically assessed as having a high environmental impact in the Great Lakes region.
Great Lakes native species susceptible to infection by R. carpio *include emerald shiner* (Notropis atherinoides), *largemouth bass* (Micropterus salmoides), *and bluegill* (Lepomis macrochirus) *(Cipriano 2011). Experimental infections have been reported in northern pike (*Esox lucius), *pumpkinseed* (Lepomis gibbosus), *golden shiner* (Notemigonus crysoleucas), *and perch (Family Percidae) (CFSPH 2007).*
Until 2011, when two fish tested positive for SVCv following a die-off of 200-300 carp in Minnehaha Creek, Minnesota (GLFHC 2012), SVCv had not been implicated in die-offs of native or non-native species in the Great Lakes, nor had there been reports of the virus in commercial aquaculture since 2003 (Cipriano 2011). It should be noted that Chryseobacterium *and* Aeromonas hydrophila *group 2 were isolated from the kidneys and* Acinetobacter baumannii-calcoaceticus *was isolated from the eyes of the fish, as well (GLFHC 2012).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1

Not significantly	0 √
Unknown	U

Symptoms of SVC include exophthalmia, darkened coloration, anemia, and hemorrhage in the gills, skin, and eyes (Fijan 1999, Fijan et al. 1971). Because of this, infected fish may be more susceptible to predation (Lafferty and Morris 1996). However, cascading food web effects have not been reported as a result of SVC infection in the Great Lakes.

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	6
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	**<u>High</u>**
2-5	Any	Moderate
0	0-1	Low

1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1 √
Not significantly	0
Unknown	U

SVCv has been reported from a koi production facility in North Carolina (Goodwin 2003) and a commercial fish pond in Missouri (Cipriano 2011), following fish mortality events.
It has also been responsible for mortality-related losses of aquacultured fish in Europe (Goodwin 2009).

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1

Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	1
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

<u>BENEFICIAL EFFECT</u>

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Rhabdovirus carpio *primarily infects common carp* (Cyprinus carpio), *koi carp* (Cyprinus carpio koi), *grass carp* (Ctenopharyngodon idella), *silver carp* (Hypophthalamicthys molitrix), *bighead carp* (H. nobilis), *and goldfish* (Carassius auratus) *(CFSPH 2007, OIE 2009). SVCv was implicated in the death of more than 1,500 carp in Cedar Lake, Wisconsin (Dikkeboom et al. 2004). However, the overall impact on the Great Lakes common carp population is minimal.*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

Scientific Name: *Scolex pleuronectis*

Common Name: Cestode

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

According to Muzzall and Whelan (2011), Great Lakes detection of S. pleuronectis have been limited to infections of the introduced round goby (Neogobius melanostomus) *at 13.5% prevalence with light infections (1-2 parasites/host) (Pronin et al. 1997). As such, it is unlikely to exert negative impacts on native fish species.*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level	1

AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR	1

It has significantly affected human health in past invasions outside of the Great Lakes	
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

In 1989, S. pleuronectis *was detected in brown trout* (Salmo trutta) *and rainbow trout* (Oncorhynchus mykiss) *in Chile (Torres et al. 1990). However, no such infections have been realized in the Great Lakes.*

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Scolex pleuronectis *is believed to be unlikely to help regulate populations of the introduced round goby (Pronin et al. 1997).*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1

Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**<u>Low</u>**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Sphaeromyxa sevastopoli*

Common Name: Myxosporean parasite

Environmental: Low
Socio-Economic: Low
Beneficial: Low

Comments: The distribution of *S. sevastopoli* in the Great Lakes appears to be limited, with no observations reported since 1995. Without documented impacts, it appears to be relatively benign in this system.

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Sphaeromyxa sevastopoli *is not known to parasitize species native to the Great Lakes basin, although myxosporeans in general incorporate both a fish and an annelid host (Wolf and Markiw 1984).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6

Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6

Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

While a parasite of introduced gobies in the Great Lakes, it is unlikely that S. sevastopoli *can regulate their populations (Pronin et al. 1997).*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √

Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

Scientific Name: *Timoniella sp.*

Common Name: A digenean fluke, trematode

Environmental: Low
Socio-Economic: Low
Beneficial: Low

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Timoniella sp. *has only been isolated in the Great Lakes from the introduced Eurasian ruffe* (G. cernua) *(Pronin et al. 1997, 1998). As such, it is unlikely to exert negative impacts on native fish species. However, members of this trematode genus have been documented to parasitize additional fish species (e.g., Kvach and Skora 2006, Zander and Reimer 2002).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6

Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6

Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

Timoniella *sp. infection of the introduced Eurasian ruffe in the Great Lakes has ranged from densities of 7-61 parasites per ruffe, with up to 100% prevalence (Pronin et al. 1997, 1998). However,* Timoniella *sp. is believed to be unlikely to help regulate populations of the introduced Eurasian ruffe.*
A relationship between resistance to anoxia in Eurasian ruffe and its parasite load has been observed, such that increased richness of parasites, including Timoniella sp., *negatively affects the ruffe's ability to survive low-oxygen conditions (Pronin et al. 1997). Furthermore, species of* Timoniella *have been documented to occur in gobies outside the Great Lakes (e.g. Kvach and Skora 2006, Malek 2003). It is not known how the presence of these parasites might affect nonnative fish population dynamics and competitive interactions with native fishes in the Great Lakes.*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6
Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

<table>
<tr><th colspan="3">Scoring</th></tr>
<tr><td>Score</td><td># U</td><td>Impact</td></tr>
<tr><td>>5</td><td>Any</td><td>High</td></tr>
<tr><td>2-5</td><td>Any</td><td>Moderate</td></tr>
<tr><td>0</td><td>0-1</td><td rowspan="2"><u>Low</u></td></tr>
<tr><td>1</td><td>0</td></tr>
<tr><td>0</td><td>≥2</td><td rowspan="2">Unknown</td></tr>
<tr><td>1</td><td>≥1</td></tr>
</table>

Scientific Name: *Trypanosoma acerinae*

Common Name: flagellate parasite

Environmental: Low
Socio-Economic: Low
Beneficial: Low

Comments: The distribution of *T. acerinae* in the Great Lakes appears to be limited, with no observations reported since 1992. Without documented impacts and its host specificity for Eurasian ruffe, it appears to be relatively benign in this system.

ENVIRONMENTAL IMPACT

Does the species pose some hazard or threat to the health of native species (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, and it has resulted in the reduction or extinction of one or more native species populations, affects multiple species, or is a reportable disease	6
Yes, but negative consequences have been small (e.g., limited number of infected individuals, limited pathogen transmissibility, mild effects on populations and ecosystems) AND/OR It has significantly affected similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Trypanosoma acerinae *was found in 10% of the introduced Eurasian ruffe* (Gymnocephalus cernua), *its only known host, sampled from Pokegama Bay, Lake Superior in 1992 (Pronin et al. 1998). It is not known to parasitize any Great Lakes native species, although trypanosomes in general incorporate both a fish and a leech host (Laveran and Mesnil 1907).*

Does it out-compete native species for available resources (e.g., habitat, food, nutrients, light)?

Yes, and it has resulted in significant adverse effects (e.g., critical reduction, extinction, behavioral changes) on one or more native species populations	6
Yes, and it has caused some noticeable stress to or decline of at least one native species population	1
Not significantly	0 √
Unknown	U

Does it alter predator-prey relationships?

Yes, and it has resulted in significant adverse effects (e.g., added pressure to threatened/endangered species, significant reduction or extinction of any native species populations, creation of a dead end or any other significant alteration in the food web)	6
Yes, and it has resulted in some noticeable stress to or decline of at least one native species population AND/OR Yes, and it has resulted in some alteration of the food web structure or processes, the effects of which have not been widespread or severe	1
Not significantly	0 √
Unknown	U

Has it affected any native populations genetically (e.g., through hybridization, selective pressure, introgression)?

Yes, and it has caused a loss or alteration of genes which may be irreversible or has led to the decline or extinction of one or more native species	6
Yes, some genetic effects have been observed, but consequences have been limited to the individual level AND/OR It has genetically affected the same or similar species in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality (e.g., increased turbidity or clarity, altered nutrient, oxygen, or other chemical levels/cycles)?

Yes, and it has had a widespread, long term, or severe negative effect on water quality AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected water quality to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly affected water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it alter the physical ecosystem in some way (e.g., facilitated erosion/siltation, altered hydrology, altered macrophyte/phytoplankton communities, changes to substrate (physical or chemical))?

Yes, and it has had a widespread, long term, or severe negative effect on the physical ecosystem AND/OR Yes, and it has resulted in significant negative consequences for at least one native species	6
Yes, it has affected the physical ecosystem to some extent, but the alterations and resulting adverse effects have been mild AND/OR It has significantly altered physical ecosystems in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Environmental Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

SOCIO-ECONOMIC IMPACT

Does the species pose some hazard or threat to human health (e.g., it magnifies toxin levels, is poisonous, a virus, bacteria, parasite, or a vector of one)?

Yes, significant effects on human health have already been observed	6
Yes, but negative consequences have not been widespread, long lasting, or severe AND/OR It has significantly affected human health in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it cause damage to infrastructure (such as water intakes, pipes, or any other industrial or recreational infrastructure)?

Yes, it is known to cause significant damage	6
Yes, but the costs have been small and are largely reparable or preventable AND/OR It has a history of causing significant infrastructural damage in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it negatively affect water quality?

Yes, it has significantly affected water quality, and is costly or difficult to reverse	6
Yes, but the effects are negligible and/or easily reversed AND/OR It has a history of significantly affecting water quality in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it harm any markets or economic sectors (e.g., commercial fisheries, aquaculture, agriculture)?

Yes, it has caused significant damage to one or more markets or economic sectors	6
Yes, some damage to markets or sectors has been observed, but negative consequences have been small AND/OR It has a history of harming markets or economic sectors in past invasions outside of the Great Lakes	1
Not significantly	0 √
Unknown	U

Does it inhibit recreational activities and/or associated tourism (e.g., through frequent water closures, equipment damage, decline of recreational species)?

Yes, it has caused widespread, frequent, or otherwise expensive inhibition of recreation and tourism	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Does it diminish the perceived aesthetic or natural value of the areas it inhabits?

Yes, the species has received significant attention from the media/public, significantly diminished the natural or cultural character of the area, or significantly reduced the area's value for future generations	6
Yes, but negative consequences have been small	1
Not significantly	0 √
Unknown	U

Socio-Economic Impact Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	
0	≥2	Unknown
1	≥1	

BENEFICIAL EFFECT

Does it act as a biological control agent for aquatic weeds or other harmful nonindigenous organisms?

Yes, it has succeeded significantly as a control agent	6
Yes, it has had some success as a control agent, but may be inconsistent or lack a desired level of effectiveness	1
Not significantly	0 √
Unknown	U

While a parasite of the introduced Eurasian ruffe in the Great Lakes, there are no known reports of T. acerinae *impacting ruffe populations.*

Is it commercially valuable (e.g., for fisheries, aquaculture, agriculture, bait, ornamental trade)?

Yes, it is economically important to at least one of these industries	6
Yes, but its economic contribution is small	1
Not significantly	0 √
Unknown	U

Is it recreationally valuable (e.g., for sport or leisurely fishing, as a pet, or for any other personal activity)?

Yes, it is commonly employed recreationally and has some perceived value for local communities and/or tourism	6
Yes, it is sometimes employed recreationally, but adds little value to local communities or tourism	1
Not significantly	0 √
Unknown	U

Does the species have some medicinal or research value (outside of research geared towards its control)?

Yes, it has significant medicinal or research value	6
It has some medicinal or research value, but is not of high priority OR It is potentially important to medicine or research and is currently being or scheduled to be studied	1
Not significantly	0 √
Unknown	U

Does the species remove toxins or pollutants from the water or otherwise increase water quality?

Yes, it reduces water treatment costs or has a significant positive impact for the health of humans and/or native species	6

Yes, but positive impact for humans or native species is considered negligible	1
Not significantly	0 √
Unknown	U

Does the species have a positive ecological impact outside of biological control (e.g., increases the growth or reproduction rates of other species, fills an important gap in the food web, supports the survival of a species which is threatened, endangered, or commercially valuable)?

Yes, it significantly contributes to the ecosystem in one or more of these ways	6
Yes, it provides some positive contribution to the ecosystem, but is not vital	1
Not significantly	0 √
Unknown	U

Beneficial Effect Total	0
Total Unknowns (U)	0

Scoring		
Score	# U	Impact
>5	Any	High
2-5	Any	Moderate
0	0-1	**Low**
1	0	**Low**
0	≥2	Unknown
1	≥1	Unknown

APPENDIX B. OIA REFERENCES

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