A Biosecurity Measure Plan for

[Insert location here]

In compliance with the

EU Legislation (Aquatic Animal Health) Regulations 2016

Managing the risk of introduction and spread of Non-native species and pathogens.

[Insert location/map here] areas. Showing [Insert location here]

Executive summary

The introduction of pathogens and non-native species (NNS) ranks as one of the major threats to ecosystems and ecosystem services and can cause massive ecological and economic damage. The presence of NNS can also potentially lead to the failure of a water body to achieve equivalence of Good Environmental Status under the European Union Marine Strategy Framework Directive (MSFD). Under Scottish law, it is regarded as a criminal offence to cause an animal to be out with its native range. Aquaculture production businesses are concerned about biosecurity as their core activities rely heavily on ecosystem integrity, whilst their operations can potentially introduce NNS and pathogens damaging to their business. Many existing biosecurity measures are focused on controlling the spread of pathogens and are obligatory for aquaculture and shellfish farms. Biosecurity Planning for NNS is an important component of sustainable practices and feature heavily in accreditation schemes such as the Aquaculture Stewardship Council bivalve standard.

This document details a Biosecurity Plan that utilises a Hazard Analysis and Critical Control Point (HACCP) approach to identify appropriate measures to manage the risk posed by both non-native species and pathogens together for [Insert location here]. The measures outlined within this Biosecurity Plan are in line with existing guidance and legislative requirements in [Insert country here]. This Biosecurity Plan focuses at the operational level of the oyster farm, and constitutes a baseline for further Biosecurity Planning at this scale. The purpose of this Biosecurity Plan is to document and manage the risk of introducing NNS and disease because of activities undertaken by [Insert location here]. This Biosecurity Plan is intended to be a working document and will be reviewed regularly to ensure that it remains fit for purpose over time. The primary objectives of this Biosecurity Plan are to:

- Identify and reduce the risk of introduction and spread of marine NNS and pathogens by introducing control measures in line with existing guidance and legislative requirements.
- Promote monitoring by daily surveillance and maintaining records in order to allow rapid response.
- Facilitate effective control programmes through a rigorous contingency plan in line with policy and engagement with stakeholders.

This document details the motivation, risk assessment method and the details of the [Insert location here] Biosecurity Measures Plan.

1. Introduction

1.1. Project Background

Invasive Non-Native Species (NNS) and pathogens constitute a major threat for biodiversity (Molnar *et al.*, 2008) and can present a hazard to activities relying on the marine ecosystem. The cost of dealing with NNS in the UK is estimated to be at least £1.7 billion per year (Williams *et al.*, 2010). [Insert location here], has produced a Biosecurity Measures Plan (BMP) to mitigate and manage the risk of NNS and pathogens. This BMP utilises a Hazard Analysis and Critical Control Point (HACCP) approach to identify appropriate measures to manage the risk posed by NNS and pathogens in line with existing guidance and legislative requirements.

1.2. Biosecurity Planning Drivers

Aquaculture and shellfish farming is considered as an activity that is capable of introducing and spreading NNS. From 145 listed NNS in the Channel and the North Sea area, around 30% appear to be introduced accidentally or intentionally by aquaculture (Boudouresque, 2005). Other marine industries are capable of introducing NNS through activities such as the movement of ballast water and bio-fouled structures (Minchin *et al.*, 2013). The main pathway related to aquaculture and shellfish farming is through the movement of live animals that can carry other organisms ("hitch hikers").

1.2.1. Promoting Sustainable Practices

Any individual involved in marine activities has a shared responsibility for ensuring that their impact on the marine environment is sustainable. Biosecurity Planning is an important component of sustainable practices and features heavily in accreditation schemes such as the Aquaculture Stewardship Council bivalve standard. Oyster farming practices can promote the introduction and settlement of NNS and potentially have a negative impact on ecosystems services and livelihoods. Therefore, oyster farmers, like all marine users, have the duty to adopt good practices and take appropriate measures to reduce their impact on the ecosystem.

1.2.2. Minimising Impact on Business

The introduction of NNS and pathogens to aquaculture operations is of large concern to oyster farmers and restoration practitioners. Indeed, there have been several instances where oyster farming in Europe has been severely affected by diseases outbreaks and NNS. Pacific oyster populations in France were devastated by a variant herpesvirus in 2008 and 2009 (Segarra *et al.*, 2008). Current research (summer 2016) being undertaken by Stirling University, CEFAS Weymouth and Jersey Sea Farms is linking herpesvirus with mortalities in *Ostrea edulis*. The presence of NNS and pathogens can drastically increase mortality of oyster and handling time during harvesting to the point it can threaten the viability of operations.

1.2.3. Working within the Law

Within the Marine Strategy Framework Directive, [Insert location here] must take measures in order to reach "Good Environmental Status". NNS introductions may adversely alter ecosystems, resulting in the failure for that ecosystem to archive Good Environmental Status. The EU Legislation (Aquatic Animal Health) Regulations 2016 extends the responsibilities.

An individual needs to demonstrate that 'all reasonable steps' have been taken and due diligence has been exercised to avoid committing the criminal offences.

1.3. Objectives of the [Insert location here] Biosecurity Measures Plan

The principal objective of this Biosecurity Planning is to document actions taken to address the risk of introducing NNS and pathogens as part of the [Insert location here] operation. This BMP has been produced in line with existing legislation and guidance to allow responsible personnel to explore the best opportunities for managing the risk of introducing of NNS and pathogens. As well as encouraging good practice, a good BMP should demonstrate that all 'reasonable steps' and all 'due diligence' have been exercised. Within this BMP the risk has been managed by introducing control measures to prevent new and secondary introductions of NNS and pathogens. Furthermore, early detection through monitoring and surveillance is included within the BMP to ensure that a rapid response to any identified problem can be achieved. This will ensure that any mitigation or eradication measures will have the greatest chance of success.

2. Methodology

During the production of this BMP, key legislation and guidance relating to the control of shellfish disease and the introduction of NNS have been consulted. A full list of these documents can be found in Appendices 1-3. This BMP follows a modified Hazard Analysis Critical Control Point (HACCP) (Britton *et al.*, 2011) approach, with a five-step plan (Figure 1) to identify and mitigate risks. Firstly, the activity is described in full detailing what, how and where elements of the operation (Section 3.1). Next the principal hazards (potentially harmful NNS and pathogens) are identified (Section 3.2) and any activities which have a reasonable risk of leading to their introduction are included in step 3. The risks associated with activities are assessed (see Section 3.3) and control measures described (Table 2). Finally, a contingency plan is described in section 3.5 and any additional monitoring to be undertaken.

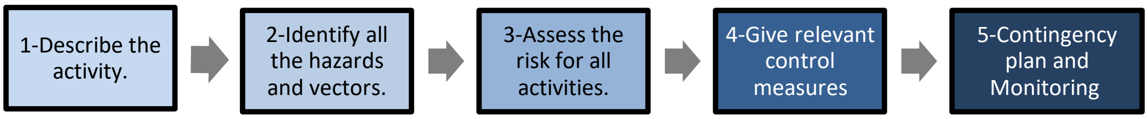

Figure 1. An illustration of the biosecurity planning process.

2.1. Risk Assessment Methodology

This BMP identifies ways in which to reduce risk through qualitative assessment of activities, and introducing control measures where necessary (i.e., where risk associated with a particular activity is shown to be high). Risk can be defined as the likelihood that a harmful event will occur multiplied by the magnitude of the consequences if the event occurs (i.e., economic loss, ecosystem damage etc.). Risk from NNS and pathogens are a combination of three main elements:

- **Potential threat –** the severity of the potential impact (economic and ecological).
- **Likelihood of Introduction –** the potential of the activities to create a suitable vector capable of carrying and introducing a NNS and/or pathogen
- **Likelihood of Establishment and Spread –** dependant on the ecological preferences and dispersal potential of NNS and/or pathogens within the recipient environment.

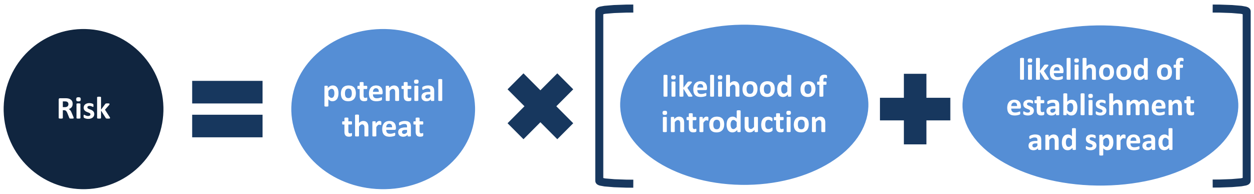

Figure 1: Conceptual model illustrating the elements of risk.

For many marine NNS, there is a limited understanding of their ecology and life history traits. The lack of this key knowledge means that large uncertainties surround the potential impact that NNS could have on surrounding ecosystems and ecosystem services. According to the precautionary principle, the difficulty in determining the potential "harmfulness" of a particular NNS means that all known and suspected NNS should be considered to be potentially harmful. When undertaking the risk assessment only the likelihood of introduction of the most threatening NNS and pathogens have been considered. Therefore, the risk associated with each activity in this BMP (Table 2), largely illustrates how an activity may affect the likelihood that NNS and pathogens will be introduced into a new area. Where adequate information is available an assessment has been made of the potential threat posed by NNS and pathogens (see section 3.2 and Appendix 4-5). This assessment has been undertaken to inform personnel of the key biological threats to be aware off.

2.1.1. Assessing Potential Threats and Likelihood of Establishment and Spread

At present, there are many NNS and pathogens that could potentially be spread by activities associated with [Insert location here] site. Information supplied by the GB Non-Native Species Secretariat (GBNNSS) was reviewed to assess the potential threat (economic and ecological) of a given NNS, their recorded presence, as well as the likelihood of establishment and spread at [Insert location here] sites (dispersal potential and ecological preferences). The overall threat from a NNS was considered to be greater if the species had already demonstrated a deleterious effect on the environment, economy, human health, property or resources in another region where it had been introduced. If environmental conditions at the site of introduction are similar to the region of NNS origin, and suitable substrate is provided, then there is a greater likelihood that a NNS will survive and become established. The risk related to pathogens has been summarised from the Fish Health Inspectorate and reviewed by Murray *et al.* (2012). Appendix 5 reviews the threats from a range of current and potential non-native species relevant to [Insert location here] aquaculture site.

2.1.2. Assessing Likelihood of Introduction

As specified in Section 2.1, the risk associated with each activity in this BMP (Table 2), largely illustrates how an activity may affect the likelihood that NNS and pathogens will be introduced into a new area. The probability that a NNS or pathogens will be introduced was assessed by determining the likelihood that activities associated with aquaculture operations at [Insert location here] would create a suitable vector. Good vectors are those that have the capacity to transport living material and have their origins in areas where there is a known presence of NNS and/or pathogens.

3. [Insert location here] Biosecurity Measures Plan

3.1. Activity Description

Contact Person: [Insert name here]	Phone: [Insert number here]
	Email: [Insert email here]

What:

[Insert location here] is a [Insert description here] located at [Insert location here]. The "shellfish farm" will be principally dedicated to native oyster restoration activities including broodstock nurseries or on-growing.

How:

[Insert description here]

Where:

[Insert location here]

3.2. Summary of key threats

Several NNS are already present in the Solent. These include, but not limited to, wireweed (*Sargassum muticum*), Pacific oyster (*Crassostrea gigas*), carpet sea squirt (*Didemnum vexillum*), leathery sea squirt (*Styela clava*), American slipper limpet (*Crepidula fornicata*) and Japanese skeleton shrimp (*Caprella mutica*).

The carpet sea squirt (*Didemnum vexillum*) has recently been found in England, Ireland, and Wales and at one location in the Clyde, on the west coast of Scotland. The potential ecological and economic impacts of this species are significant, including the overgrowth of fish spawning grounds, the prevention of demersal fish species foraging on benthic prey and the interference with aquaculture (fin- and shellfish), fishing and other coastal and offshore activities.

The veined rapa whelk (*Rapana venosa*) is likely to be introduced due to suitable environmental conditions and wide dispersal potential of larvae. Successful establishment of reproductive populations is less certain owing to the apparent requirement for water temperatures of 18°C for extended periods for egg case laying, hatching and larval development to occur (GBNNSS). *Rapana venosa* would present a high risk to native bivalves through competition for resources. The lack of competition and predation on *R. venosa* and a non-specific diet have resulted in the decimation of native bivalve populations in the Black Sea (ICES 2004).

The main pathogen hazard for [Insert location here] is *Bonamia ostreae* which is present in the Solent already, so the risk is posed by an outbreak within oysters held at high density. A risk is also posed by a similar species, *Bonamia exitiosa* which was ephemerally detected (Helmer *et al.* 2020).

The risk from infection by the protistan parasite *Marteilla refringens* is considered as moderate because this species requires low salinities for both sporulation and disease outbreaks (OIE, 2015). This species is currently limited to the River Tamar in the UK.

The risk linked with other pathogens is considered as low. For example, *Mikrocytosis mackini* (Denman Island disease) can cause up to 40% mortality in infected oysters up to three years or older. However, it has not yet been found in oysters in the UK. Water temperatures greater than 20°C are required for disease outbreaks caused by the protist *Perkinsus marinus* (Murray *et al.*, 2012). Oyster herpesvirus is present in Poole Harbour and other locations (River Teign Lee-over-sands to Port Richborough, Butley Creek, and Essex, Kent and Suffolk), however, there is limited information indicating detrimental effects to native oysters.

3.3. Risk assessment results

The risk associated with each activity was assessed and is presented in Table 2, along with supporting comments and control measures. A summary of the main activities undertaken by [Insert location here] that have the potential to facilitate the introduction of NNS and pathogens is given bellow.

- **Movement of live shellfish:**
  Movement of live shellfish is likely to be the major introduction vector for NNS (Murray *et al.*, 2012) and movements of infected hosts (i.e., live shellfish) is the most effective way of moving pathogens (Murray *et al.*, 2012). Therefore, the importation of shellfish from areas where an infection is present is a high-risk factor in terms of the introduction of pathogens, and therefore strict control measures are required for shellfish movements. To maintain the health status of the area and prevent the spread of disease, imports must come from countries, zones, or farms with at least the equivalent health status. Selecting naïve populations reduces the risk of introduction but increases their likelihood of infection and mortality where the individuals or genetic stock have not been exposed previously.

- **Movement of peoples and vehicles:**
  People and vehicles entering the intertidal area can potentially introduce NNS and pathogens by carrying pathogens, live individuals, eggs, and larvae, especially if they are coming from an area where disease and/or NNS are present.

- **Movement of gear**:
  Gear such as trestles and boxes that have been previously in contact with the marine environment can be colonised by NNS and moved to another area.

- **Creation of novel habitats:**
  Oyster farming infrastructure can offer suitable habitat for non-native species where none would otherwise exist in the natural environment. Artificial structures have been

recognised as creating preferential conditions for the colonisation of NNS (Tyrell *et al.*, 2012).

- **Other marine activities:**

  Within the [Insert location here] site of operations and the surrounding geographical area other marine activities are taking place and may present a risk of introduction of NNS and pathogens. [Insert location here] has little or no control over these activities, which may include:

  -intentional introduction or release;

  -movement of hull fouling and ballast water from commercial and private vessels;

  -movement of NNS and pathogens associated with surrounding aquaculture activities;

  -movements of marine recreational equipment and vessels.

Table 1. Risk assessment and control measures for activities associated with aquaculture production at [Insert location here]. Red = High risk; Orange = Medium risk; Green = Low risk.

Activity description		Mitigated risk	Justification	Control measures
Movement of Live Shellfish	**Movement of juvenile oysters from sites outside of the Solent**	High	The oysters could contain pathogens or be colonised by NNS. Larvae and young oysters can carry pathogens. Pacific oysters are difficult to distinguish from native oysters when younger so there is a risk of importing this way.	• **Establish the exact provenance of animals before purchase. If seed and/or oysters are produced in an area known to have been recently affected by diseases or NNS then ensure additional control measures undertaken before moving animals. Endeavour to use locally obtained stock whenever possible, thereby avoiding translocation of stock from one area to another.** • **Only accept oysters that have been certified to be of equivalent or lesser disease status by the FHI. If importation occurs from a separate health zone country, it must be accompanied by a health certificate issued by the competent authority in the country of origin. The FHI must be notified of movements from other EU Member States, zones or compartments or EFTA States at least 24 hours prior to arrival of the consignment. Notification of the arrival of these consignments should be made using the appropriate form.** • **Check for signs of disease before introducing shellfish to a new site. These checks and subsequent control measures should be undertaken at the point of origin. Oysters which show signs of disease must be rejected and the incident reported in the farm logbook. Large mortality incidents (>15%) must be reported to FHI.**
	Movement of broodstock oysters from sites outside of the Solent	High	The broodstock could contain pathogens or be colonised by NNS.	

	Activity description	Mitigated risk	Justification	Control measures
	Seed from Solent hatchery	Low	Treated seawater (i.e., filtered and treated) used in the hatchery and controlled process along with an awareness of potential threats means that risks associated with this activity is considered low. The hatchery also uses water from the same body (Solent).	• **Before introducing shellfish to a new site check all shellfish and associated materials for the presence of other marine species. Ideally these checks and subsequent control measures should be undertaken at the point of origin. Ensure that any material that is heavily fouled, has unusual biofouling and/or associated hitchhikers is kept separate from the marine environment.** • **Steps taken to remove associated species must be undertaken responsibly or shellfish should be rejected. Any rejected material must be disposed of responsibly and the incident logged.**
	Importation of seed from hatchery outside of the Solent	Medium	The likelihood that larvae contain NNS is considered to be low. Larvae and young oysters can carry pathogens. Pacific oysters are difficult to distinguish from native oysters when younger so there is a risk of importing this way if hatcheries produce both species.	

Activity description		Mitigated risk	Justification	Control measures
	Movement of Oyster to other growing sites	Medium	Pathogens or NNS could be present at the [Insert location here] site and therefore be transferred to other growing sites through animal movement. However, staff at the site have an awareness of the potential threats and undertake checks for both pathogens and non-natives before animals are moved. For these reasons this activity is considered to be of medium risk.	• **Oyster farmers must notify the FHI of an impending export using the appropriate Export notification form.** • **Check for signs of disease before introducing shellfish to a new site. Ideally these checks and subsequent control measures should be undertaken at the point of origin. Oysters which show signs of disease (i.e., large number of gaping shells) must be rejected and the incident reported in the site logbook. Large mortality incidents (>15%) must be reported to FHI.** • **Before introducing shellfish to a new site check all shellfish and associated materials for the presence of other marine species. Ideally these checks and subsequent control measures should be undertaken at the point of origin, however, this can also be undertaken under strict condition in the recipient site. Ensure that any material that is heavy fouled, has unusual biofouling and/or associated hitchhiker(s) is kept separate from the marine environment. Steps taken to remove associated species must be undertaken responsibly or shellfish should be rejected. Any rejected material must be disposed of responsibly and the incident logged.**
	Broodstock sent from Solent sites to Solent hatchery	Low	Pathogens or NNS could be present at the [Insert location here] site and therefore be transferred to the hatchery. However, staff at the site have an awareness of the potential threats and undertake checks for both pathogens and non-natives before animals are moved. Further checks should be encouraged before the hatchery accepts broodstock. Stock is being moved within the same body of water. Thorough cleaning should take place prior to them entering the hatchery.	

	Activity description	Mitigated risk	Justification	Control measures
Movement of gear and vehicles	**Movement of land vehicles.**	Low	Movements of vehicle are not likely to introduce pathogens or NNS. However, consideration should be given to any vehicle, owned, or rented by staff, that may have contact with a site containing diseased animals and/or a highly prevalent NNS. Cases have been reported were lorries entering the UK have been able to transport pathogens (Kennedy *et al.*, 1990).	• **Vehicles that have been used to transport oysters should be cleaned appropriately after use. Vehicles that are suspected to be carrying either pathogens or NNS should be washed before entering the intertidal area to remove all sediment and organic matter, especially tyres and wheel arches. Ideally these measures would be undertaken at the point of origin.**
	Movement of gear between sites.	High	Individuals, larvae, and fragments of NNS can stick to gear and be transported to other sites. Pathogens can potentially be carried at the same time. The movement of heavily fouled gear (i.e., submersed in the marine environment for a long time) presents the greatest risk of introducing NNS.	• **Site specific equipment should be used where possible. Gear originating from any other sites must be cleaned at the point of origin and disinfected where pathogen spread is suspected.**
Movement of peoples	**Public access to sites.**	Low	People can carry NNS and pathogens on their being, particularly if they have recently been in an area where NNS and pathogens are present. Unless connectivity can be established between an area that has NNS and pathogens and the site, the risk from this activity is considered to be low.	• **Restrict access to aquaculture sites by general public. Warning notices should be placed at each site access stating "Farm site, restricted access, hygiene consideration."**
	Movement of staff (and volunteers) to and from sites.	Low	People can carry NNS and pathogens on their being, particularly if they have recently been in an area where NNS and pathogens are present. Unless connectivity can be established between an area that has NNS and pathogens and the site, the risk from this activity is considered to be low.	• **Cleaning equipment should be made available for individuals visiting the site before and after entering the area.**

Activity description		Mitigated risk	Justification	Control measures
Habitat creation	**Condition of site equipment and facilities.**	Medium	It is recognised that NNS thrive on artificial structures; consequently, site equipment and facilities such as trestles and boxes can offer a suitable habitat for NNS and promote their settlement and spread. Thus, it is important to keep site equipment and facilities in good condition. Regular visual inspection of site equipment to identify key threats may be necessary.	• **Regularly clean site equipment & structures to remove any fouling organisms.** • **Regular visual inspection of site equipment for key threats.**
Disposal of oysters	**Disposal of deceased oysters and shell material**		Deceased oyster tissue can be a vector for the spread of pathogens, including *Bonamia ostreae* and *Bonamia exitiosa.*	• **Oyster flesh should be disposed of in general water on site and contact with the water body should be avoided.** • **Oyster shell material can either be collected and stored away from the water body to be used for other restoration purposes (cleaning and weather of the shell is required prior to this), or material can be passed on to the Solent Oyster Restoration Project to do similar activities.**
Other activities	[Insert additional info here]		[Insert any additional information here]	• [Insert additional measures here]

3.3.1. Responsible Transportation

The [Insert location here] site will aim to implement best practice during transportation of live or dead shellfish and equipment to maintain healthy shellfish stocks and reduce the introduction and spread of NNS and pathogens. Transportation will be undertaken in a way to reduce the probability of carrying NNS and pathogens.

This includes:

- Removing biofouling from shellfish and gear.
- Use of clean and disinfected boxes to carry shellfish.
- Checking that no other live material is added to the boxes.
- Checking the boxes for NNS before transportation.

3.3.2. Responsible Cleaning and Disinfection

Certain NNS can be induced to spawn when damaged and through physical abrasion, while others can survive being dislodged or broken into fragments. Therefore, washing and sorting will take place in an appropriately enclosed area where there is no risk of runoff reaching the sea. All debris must be safely disposed of according to guidelines for biological waste.

Cleaning and disinfection of gear:

- Remove visible organic material by power-washing with fresh water, scraping and brushing, and using detergent if necessary to remove grease or fats.
- Choose an appropriate disinfectant. In general, use a disinfectant which is effective against a broad spectrum of disease agents (e.g. Vikron 1% or Bleach).
- Dilute the disinfectant to the recommended concentration, referring to the manufacturer's instructions.
- Apply the disinfectant to all surfaces to be treated and leave for the recommended contact time.
- Rinse with clean freshwater, if necessary.

Cleaning of shellfish:

Seed/juvenile cleaning can induce higher mortality; thus it is advisable to carefully check seed rather than undertaking cleaning procedures. Broodstock oysters can be cleaned more rigorously by hand.

- Dry-off shells for 12 hours.
- Clean shells.
- If high suspicion of the presence of NNS remains, additional measures should be taken such as heat treatment, freshwater flushing, or immersion in a high salinity bath.

3.3.3. Responsible Disposal

Waste management is an important component of shellfish operations, as waste is generated regularly during normal operations. Subject to safe operating conditions, mortalities should be removed daily and should be disposed of by an approved method in accordance with Regulation (EC) 1774/2002. Local authorities have responsibility for waste disposal. Correct disposal of live material is vital to avoid the risk of spreading the problem further. Always contact the local authority for advice on disposal because there are regulations that cover the composting, burning and burial of live material on-site and the transfer and disposal of material to licensed or permitted landfill sites.

3.4. Surveillance and Monitoring

Shellfish farmers are legally obliged to maintain an up-to-date record of mortalities, biosecurity measures and stock movement, and to make such records available for inspection during FHI's visits, or as requested. Continuous surveillance and monitoring are crucial for any biosecurity strategy, as it may help to identify the origin of NNS and pathogens and thus allow more efficient response to a disease outbreak or any NNS. Monitoring is also a way to provide evidence that the objectives of the BMP are being met. In addition, it is essential to keep the BMP updated and carry out a regular risk assessment for any new activities, pathogen or NNS. For the oyster grower, surveillance and monitoring will consist in keeping a daily record of mortalities, shellfish movement and any unusual sightings and informing the FHI of any new activities.

3.5. Contingency Plan

A comprehensive BMP should acknowledge that the biosecurity measures outlined may not be sufficient to avoid the introduction of a NNS or pathogens, and thus should include a contingency plan. The contingency plan explores potential scenarios and gives relevant control actions. Incorporating a contingency plan within a BMP allows possible actions to be pre-defined which could be implemented rapidly if NNS or pathogens are found/introduced despite adherence to the control measures outlined in the Biosecurity Plan.

3.5.1. Objectives

Respond quickly and appropriately once an NNS or disease is detected to reduce the potential for further spread and detrimental effect on the local ecology and/or economy.

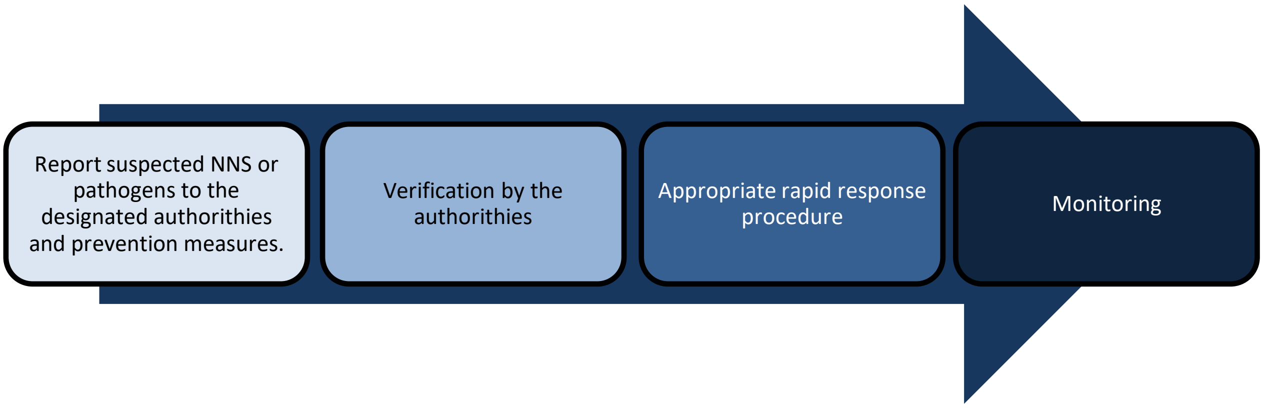

Figure 2. Contingency Plan process.

3.5.2. Mortality events

Unexplained mortality or a sudden increase in mortality in a batch of shellfish (>15%).	• Inform the FHI. • Store mortalities in a secure manner prior to disposal in accordance with official guidance. • Identify the source through survey and sampling. • Determine the extent of the spread. • Contain the threat and where possible prevent it from spreading to other areas.
Shellfish mortalities continuing.	• Contain the threat and prevent the problem from spreading to other areas. • Restrict access to affected stock where possible.
Need to dispose of dead shellfish.	• Do not return moribund shellfish to biosecure zones once they have been removed. • Identify a suitable site for disposal, in accordance with the waste disposal regulations. • Contact the local health authority for advice on the method of disposal. • Contain the mortalities in a manner which reduces the risk of infection spreading to other parts of the area.

3.5.3. Non-Native Species discovery

Stage One–The discovery of an unknown species on the site which is suspected to be non-native. • Collect sample, place in plastic bag in a freezer and contact Natural England.

Stage two – Presence of high alert species confirmed. • Initiate immediate containment measures, including restricted movements. If suspected NNS is on a piece of equipment (e.g. Trestle, boxes), remove from the water and allow drying on land. • Carry out wider survey of vessels and structures in order to determine the size and distribution of the NNS population at the site of introduction.
Stage three – If the NNS is a species of major concern or well established within the site, the following treatments could be considered in consultation with local authorities: • **Exposure to air:** Drying is the most effective and inexpensive method of NNS removal; indeed long exposure to air is lethal for most NNS. This method is currently used by the aquaculture industry to remove fouling species (both native and non-native) from structures, equipment and shellfish shells. • **Jet washing:** Artificial structures that can be removed from the water, such as trestles and boxes, can be jet washed, preferably with fresh water to remove any biofouling. Washing must be done in an appropriate enclosed area where there is no risk of runoff reaching the sea and that all debris is safely disposed of according to guidelines for biological waste. • **Mechanical removal or manual removal:** In addition to removing NNS by hand there are a number of tools to assist with NNS removal, such as suction or vacuum devices, particularly effective for NNS that can disperse by fragmentation (e.g. *Didemnum vexillum* and *Dasysiphonia japonica*) or dredging. • **Chemical treatment of equipment:** Chemical treatments, such as biocides, chlorine, ozone, hydrogen peroxide, chlorine dioxide, acetic acid, etc. can be used to directly and indirectly treat for NNS. Dipping seed mussels, coated with a non-native sea squirt *Didemnum* spp. in a 0.5% solution of bleach for 2 min was a 100% effective method of treatment for the invasive sea squirt and it left the mussels relatively unaffected (Denny *et al.*, 2008; Locke *et al.*, 2009). The dipping of oysters, and associated species, in saturated or strong salt solutions is also a cheap, safe and effective treatment for non-native sea squirts and *Sargassum muticum* without harming the oysters (NIMPIS 2002).

4. Abbreviations

APB - Aquaculture Production Businesses

BMP - Biosecurity Measures Plan

DEFRA - Department for Environment, Food and Rural Affairs

EFTA - European Free Trade Association

FHI - Fish Health Inspectorate (Cefas)

GBNNSS - GB Non-Native Species Secretariat

INNS - Invasive Non-Native Species

MSFD - Marine strategy Framework Directive

NNS - Non-native Species

WFD - Water Framework Directory

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Appendix 1: Legislation and Policy

The shellfish farming industry in England is controlled by a variety of legislation and policy operating at national and EU levels.

- Council Directive 2007/708/EC of 11 June 2007 on Trade and Imports of Aquaculture Products - Aquaculture. Retrieved April 1, 2015, from http://ec.europa.eu/food/animal/animalproducts/aquaculture/index_en.htm
- Council Directive 2006/88/EC of 24 October 2006 on animal health requirements for aquaculture animals and products thereof, and on the prevention and control of certain diseases in aquatic animals. Retrieved April 13, 2015, from http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32006L0088
- Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive), Retrieved April 1, 2015, from http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0056
- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (WFD) , Retrieved April 1, 2015, from http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060
- Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species. Retrieved April 13, 2015, from http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1417443504720&uri=CELEX:32014R1143
- EU Legislation (Aquatic Animal Health) (Jersey) Regulations 2016

Appendix 2: Guidance

- Import or export live fish and shellfish - Detailed guidance - GOV.UK. Retrieved April 1, 2015, from https://www.gov.uk/import-or-export-live-fish-and-shellfish
- Payne, R., Cook, E.J. and Macleod, A. (2014). *Marine Biosecurity Planning – Guidance for producing site and operation-based plans for preventing the introduction of non-native species*. Report by SRSL Ltd. in conjunction with Robin Payne to the Firth of Clyde Forum and Scottish Natural Heritage. Ref. 00954. 39 pp
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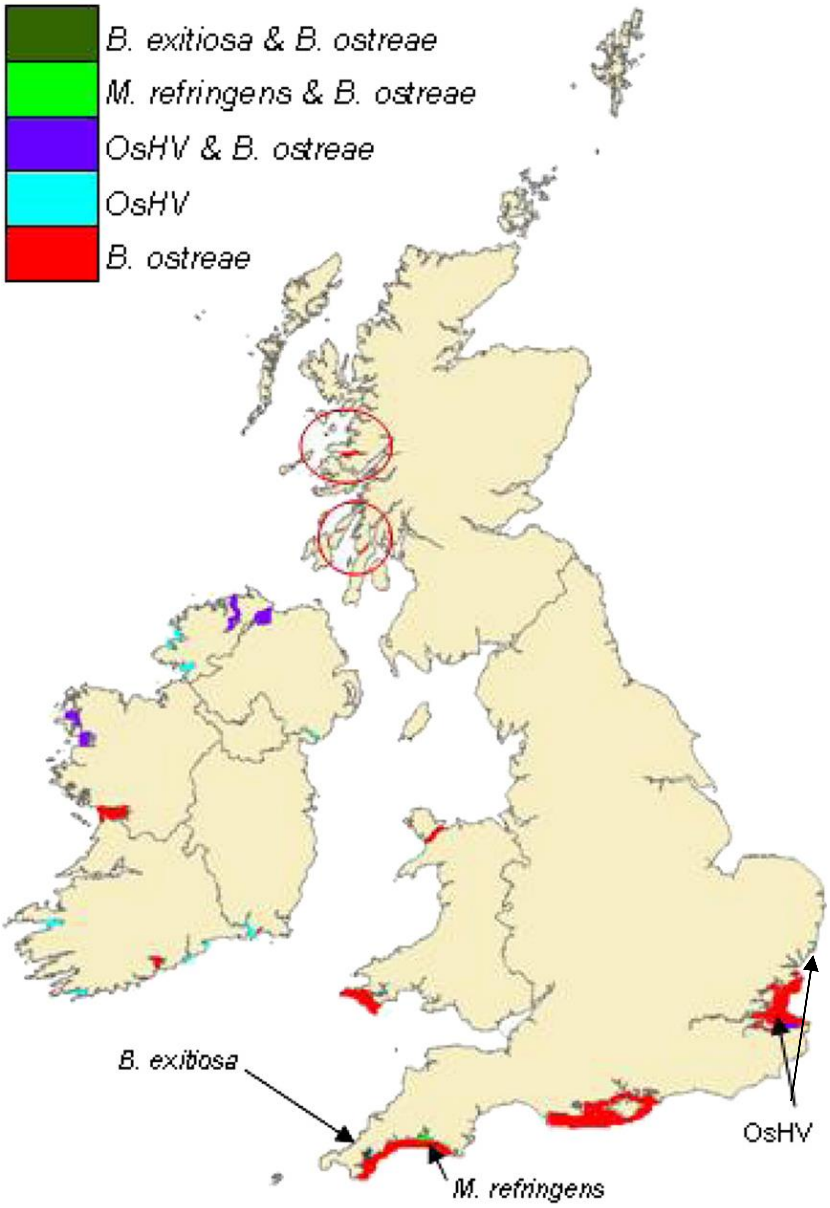
- DEFRA. The Invasive Non-Native Species Framework Strategy for Great Britain. London: DEFRA, 2008. Contract No.: PB13075
- ICES. 2005. ICES Code of Practice on the Introductions and Transfers of Marine Organisms 2005. 30 pp.
- Association of Scottish Shellfish Growers (ASSG). 2005. Code of good practice.

UK and Ireland disease management areas relevant to the Solent, from Murray *et al.* 2012.



Non-Native Species threats

The information provided bellow has been sourced from the GB non-native species secretariat at http://www.nonnativespecies.org/home/index.cfm (accessed 4.10.15) and adapted thereafter.

Orange-tipped sea squirt , *Corella eumyota.* PRESENT IN THE SOLENT

Hazard- Medium

A non-colonial sea squirt up to eight cm length, native to the southern hemisphere.

Status

Recorded around south coast of England and to Lowestoft by 2009, and spreading rapidly.

Habitat and Ecology

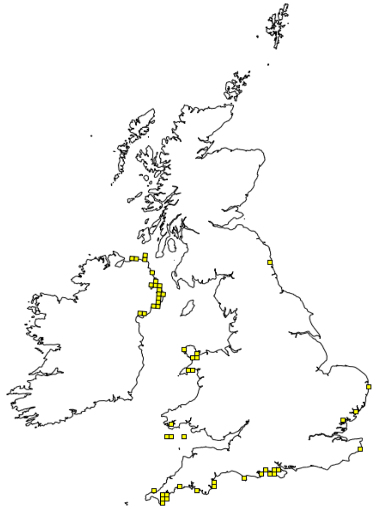
Mainly marinas and harbours, but capable of colonising natural habitats, e.g. shores in Plymouth Sound and the Yealm Estuary, Devon. Also occurs sub-tidally in native range, and likely to do so in the UK. Can disperse as larvae over a small area.

Environmental Impact

Corella eumyota populations might have a negative effect on the abundance and habitat occupancy of other shallow-water suspension feeding sessile invertebrates. However, it is not clear whether this would cause the local extinction of any species.

Economic Impact

The species' potential abundance, coupled with the formation of dense clumps, means it could become a significant fouler of mussel and oyster culture gear, potentially competing for food with target species or smothering them, and rendering underwater gear and lines extremely cumbersome.



Source: NBN Gateway

American oyster drill *Urosalpinx cinerea*

Hazard- High

A tall, conical shell, up to four cm high and two cm broad.

Status

The American oyster drill is found on the Essex and Kent coasts, especially in estuaries and associated with oysters. This species has no free swimming stage in its life history and so any natural dispersal is slow and occurs only on a local scale.

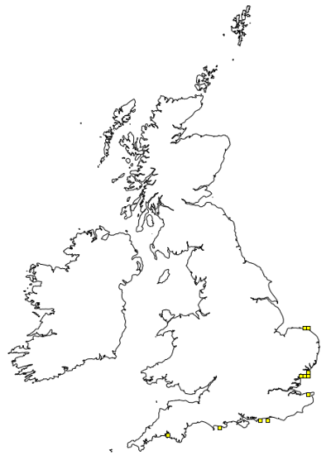
Habitat Summary

The American oyster drill inhabits the lower shore and shallow subtidal waters to depths of around 12-15 metres. It prefers the muddy bottoms of estuaries and is often found feeding on oyster beds.

Environmental Impact

The American oyster drill preys heavily on native oysters and may compete with native molluscs such as the dog whelk *Nucella lapillus*.

Economic Impact The feeding activities of the American oyster drill can decimate commercial oyster populations. 50 % mortalities among oyster spat directly attributable to this predatory snail were commonly reported. Loss of revenue may also occur due to restrictions on movement of stock from areas known to be affected by this species.



Source: NBN Gateway

Carpet sea-squirt, *Didemnum vexillum.* PRESENT IN THE SOLENT

Hazard- High

Pale orange, cream or off-white colonies forming extensive, thin (2-5 mm) sheets.

Status

Carpet Sea-squirt has been recorded in a total of nine marinas in GB: N Wales, Devon, the Solent and the Clyde.

Habitat and Ecology

Recorded in GB only from marinas and adjacent shallow artificial structures. In other areas of introduction, also occurs on natural cobble or gravel seabed to 80m depth, in tide pools on shore, in sea grass beds and on bivalve aquaculture installations.

Dispersal potential

Can disperse as larvae (few hours) or by fragmentation (up to 30 days).

Environmental Impact

Capable of forming very large colonies, and likely to have considerable effect on pre-existing sessile hard-surface communities through overgrowth interactions etc.

Economic Impact

Possible impacts on the shellfish industry. D. vexillum readily overgrows mussels and aquaculture gear. In the Marlborough Sounds mussel farming area of New Zealand, despite initial concern and substantial expenditure on control measures, effects were less severe than initially feared and farmers subsequently opted for a ‘live with it’ policy, rather than seeking funds for ongoing intensive control measures.

Source: NBN Gateway

***Botrylloides violaceus*.**

Hazard- Medium

Colonial sea squirt.

Status Well established in harbours and marinas along the south coast of England, plus the east coast as far north as Grimsby, and in Milford Haven (Wales).

Habitat and Ecology

Harbours and marinas on pontoon floats, ropes, floating fenders etc. Also on natural shores on seaweed and other solid surfaces in at least some places; reported on sheltered shores in Plymouth Sound and Milford Haven, and probably under-recorded. Can tolerate temperatures from -1 to 27°C, 15 to 33 ppt of salinity but only resistant to short air exposure.

Environmental Impact

Capable of forming very large colonies, and likely to have considerable effect on pre-existing sessile communities through overgrowth interactions. Might therefore have a negative effect on the abundance and habitat occupancy of other shallow-water suspension feeding sessile invertebrates.

Economic Impact

The species potential abundance, coupled with the formation of large colonies, means it can become a significant fouler of mussel and oyster culture gear, potentially competing for food with target species or smothering them, and rendering underwater gear and lines extremely cumbersome.

Source: NBN Gateway


Image: David Fenwick

Leathery sea squirt, *Styela clava.* PRESENT IN THE SOLENT

Hazard- Medium

A brown, non-colonial (unitary or 'solitary') sea squirt up to 20 cm tall.

Status

The leathery sea squirt is established from the Clyde (Scotland) around the south coast of England and to the Humber, the northern limits appearing relatively stable.

Habitat and Ecology

Attached to solid surfaces in shallow water, especially in harbours and marinas but also on wrecks and natural rock bottoms. Can only spread as larvae.

Ecological preferences

Can cope with temperature from -2 to 23°C but can only reproduce at temperatures >14°C: Adults can cope with salinities >10 ppt and larvae >18 ppt. Can survive out of water for up to 3 days.

Environmental Impact

Styela clava is a relatively large organism that can reach high densities, sometimes being the dominant species in shallow sheltered habitats. The species might thus have a negative effect on the abundance and habitat occupancy of other shallow-water suspension feeding sessile invertebrates. However, it is not clear whether this would cause the local extinction of any species.

Economic Impact

The species has been documented as a serious pest in long-line mussel farms in Prince-Edward Island, Canada, with reports of similar effects within the native range, in Japan. It can compete for food with mussels or oysters and partially smother them, and can foul ropes, buoys, moorings, ships etc. heavily.

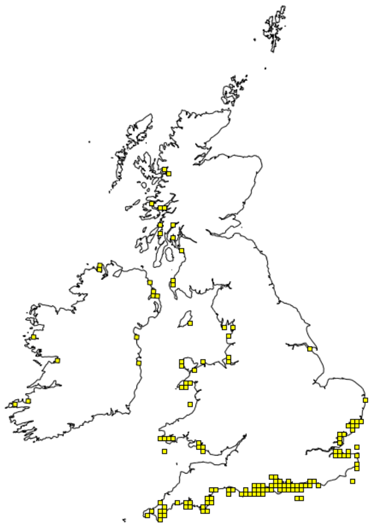

Source: NBN Gateway


Image: Matthew Jeanes

Stripped anemone, *Haliplanella lineata.*

Hazard- low

Diadumene lineata is a small anemone, originating in East Asia that can now be found on both east and west coasts of North America, Europe, Indonesia, New Zealand, and the Hawaiian Islands.

Habitat and Ecology

It is found attached to solid substrata (e.g. the underside of stones and shells) in intertidal pools or shallow waters.

Dispersal Potential As Larvae (up to two weeks).

Ecological Preferences temperature range: 14 to 24 °C; salinity range: 18 to 34 ppt; exposure to air: Short.

Impacts

Diadumene lineata is a fouling species that can be found on harbour and marina structures, mussel lines and oyster beds, and boat hulls. Its economic impact is thought to be low.


Source: NBN Gateway

***Schizoporella japonica*.**

Hazard- low

Bright orange-red, calcified, encrusting bryozoan; forming extensive sheets that grow into foliose lobes.

Status

Discovered initially in Holyhead marina in N. Wales in 2010, and then in Stromness and Kirkwall marinas in Orkney (2011). It has now spread around the Scottish coast (Ryland *et al.* 2014), and has been found in marinas in Plymouth (2012).

Habitat and Ecology

Worldwide it is usually found in harbours and marinas, on hard substrates such as pilings and hulls; or intertidally on rocks, boulders and on shellfish such as oysters and mussels. It is tolerant of salinities from18 to 34 ppt and temperatures from 7 to 19°C.

***Bugula neritina*.**

Hazard- low

A bushy, red-brown or golden-brown, flexible growth resembling finely branched red seaweed, up to 8 cm long.

Status

Occurs from south-west Scotland around the Welsh and English coasts to Lowestoft.

Habitat

In shallow water in protected sites, especially harbours and marinas.

***Watersipora subtorquata.* PRESENT IN THE SOLENT**

Hazard- low

Rigid encrusting colonies, up to several cm across consisting of 1 mm individuals arranged as a continuous sheet, often forming rounded lobes.

Status

This bryozoan is only known from a few localities on the south coast of England (first records 2008), but is likely to spread rapidly.

Habitat and Ecology

Attached to solid surfaces in shallow water, especially in harbours and marinas: pontoon floats, wave screens, hulls and mussels. In northern France, also occurs on natural shores, especially under boulders on the lower shore. Can disperse as larvae (1day), can cope with temperature from 25 to 49°C and salinity from 12 to 28 ppt but only cope with a short expose to air.

Asian shore crab, *Hemigrapsus sanguineus.*

Hazard- medium

A small crab with a square carapace (shell) up to 4.5 cm, variable in colour from orange-brown to greenish-black.

Status First recorded in South Wales and Kent in spring 2014. Specimens have been reported from Jersey and Guernsey since 2009.

Habitat summary: The Asian shore crab inhabits estuarine and marine habitats and occurs within the intertidal or shallow subtidal zones. It is typically found on more exposed rocky shores but also occurs in soft sediments under the shelter of rocks or shells, artificial structures, mussel beds and oyster reefs.

Environmental Impact

Significant reductions in common shore crab abundance and mussel density have been reported where the Asian shore crab has achieved high densities in mainland Europe, and similar effects across the broader community may be expected Recruits and juveniles of other invertebrates including snails, barnacles and polychaetes may also be threatened due to increased predation.

Economic Impact It has been suggested that Asian shore crabs could pose a threat to mussel and oyster growing operations. Potential competition with species of economic value which spend their juvenile phase in the intertidal zone, including the edible crab *Cancer pagurus* may also present a concern.

Japanese skeleton shrimp, *Caprella mutica.* PRESENT IN THE SOLENT

Hazard- medium

A large skeleton shrimp. The Japanese skeleton shrimp has established populations in the North Sea, the west coast of Scotland, in the Irish Sea and English Channel.

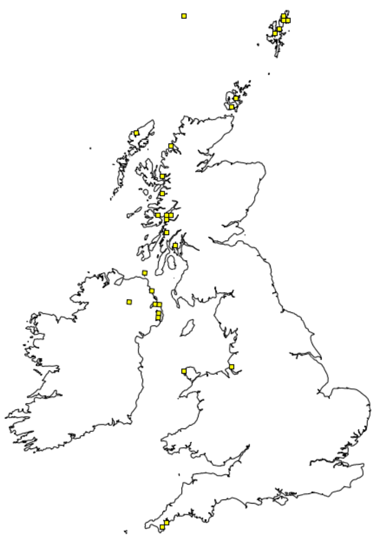
Habitat and Ecology

Typically found on a range of natural substrata including hydroids and attached or drifting macro-algae (seaweed), and also artificial substrata such as ropes, buoys, boat hulls and floating pontoons. Often found associated with areas of human activity; marinas, harbours, aquaculture sites. Only disperses as adults; Wide temperature tolerance range, Cannot tolerate low salinities; can tolerate air exposure.

Environmental Impact

The wider environmental implications have yet to be confirmed, but it is possible that it will have a significant impact on benthic communities where it competes with native species.

Economic Impact In the summer months, high densities of Japanese skeleton shrimp have been known to block water intakes on pumps for the feeding systems at caged fish sites and have settled on mussel lines which should have been covered with juvenile mussels. Economic costs associated with removal of fouling organisms and loss of utility may be incurred.



Source: NBN Gateway

Wireweed, *Sargassum muticum.* PRESENT IN THE SOLENT

Hazard- medium

Highly distinctive large olive-brown seaweed (often over 1m long).

Status Wireweed is present at suitable habitats along the south and west coasts of England, Wales and Scotland.

Habitat and Ecology

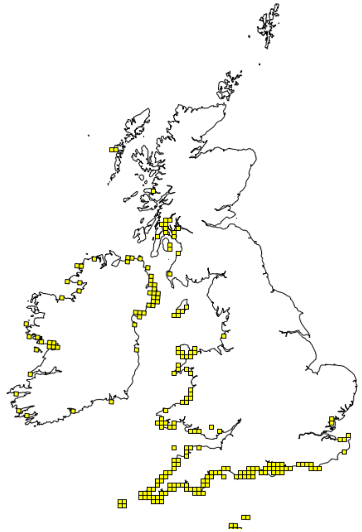
Grows on hard surfaces in shallow waters and intertidally, particularly in rockpools. The species can also tolerate estuarine conditions. It can become detached and found floating in the sea. It is highly adaptable and tolerant to a wide range of abiotic conditions and can thrive in many different environments. *Sargassum muticum* has a rapid growth rate, high fecundity, and a long life span. It is believed that *S. muticum* was initially introduced to England during the importation of the Pacific oyster (*Crassostrea gigas*) from British Colombia, Canada.

Environmental Impact

Wireweed out-competes native species. Abundance of wireweed has been correlated with reduction in diversity of native seaweeds and other species such as sea oak. Dense stands reduce light, increase sedimentation and alter temperature in rockpools.

Economic Impact

Wireweed fouls commercial oyster beds and fishing gear, increasing costs associated with these activities. Dense stands may inhibit recreational activities reducing tourism and recreation related financial income in some places. Removal from man-made structures also contributes to economic costs.



Source: NBN Gateway

Veined rapa whelk, *Rapana Venosa.*

Hazard- high

A large, active predatory snail, growing up to 18 cm in length.

Status The rapa whelk is not currently thought to be established in GB. Several individuals were caught by fishermen in 2005 in the North Sea 30 km south of the Dogger Bank suggesting that the species may be present offshore.

Habitat and ecology: Usually found on and under soft sediments from 3 – 90m water depth. The species is also occasionally found on hard and mixed substrates. Requires 18 °C for extended periods for successful reproduction.

Environmental Impact The rapa whelk is able to rapidly consume large quantities of prey and could become a serious competitor for the native common whelk. Reduced food availability may also impact other predators of bivalves including crabs, birds, fish and starfish. The provision of larger shells to hermit crabs may allow increased growth and increased demand by hermit crabs on food resources.

Economic Impact The diet of this voracious predator includes molluscs of commercial interest including oysters, mussels and clams; it has been predicted that successful establishment of this species in GB may threaten the bivalve industry.

Slipper Limpet, *Crepidula fornicata.* PRESENT IN THE SOLENT

Hazard- High

Shell is oval and up to 5 cm in length. Commonly found in curved chains or stacks made up of several individuals.

Status

Well established on the southern coasts of England and Wales and spreading northward. Now present on the east coast (up to Spurn Head) and west coast (up to Cardigan Bay) of England and in Scotland.

Habitat and Ecology

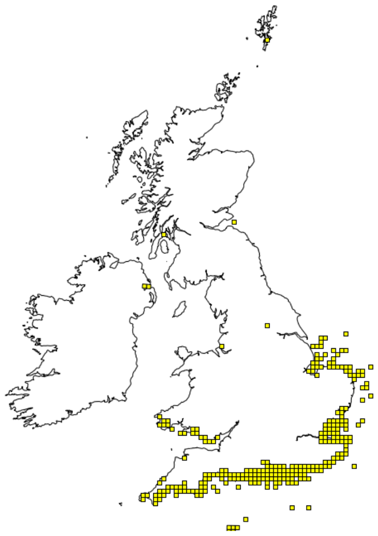
Adults live on the seabed on a variety of surfaces in a wide range of environmental conditions. Reaches its highest densities in wave protected muddy areas. Often attaches to the shells of dead and living hard-shelled invertebrates including scallops, crabs, whelks and mussels. Larvae are pelagic and are found in the water column. The slipper limpet is tolerant of a wide range of temperature conditions through all life stages and can survive low water quality.

Environmental Impact

Spatial competition occurs when numerous stacks of slipper limpets prevent other seabed species from settling and through the deposition of faeces and sediments they reduce hard-surface habitat availability. Competition for food may occur with other filter feeding species, including certain bivalves. Attachment to species, including mussels and mobile species may lead to a reduction in survival, growth and reproduction of the host. On a large scale, slipper limpet stacks have been shown to disturb normal water flow, trapping fine suspended particles. Large numbers can also reduce drainage of oyster beds during ebb tides, disturbing oyster metabolism.

Economic Impact

Bivalve fisheries: Additional costs are likely to be associated with cleaning shells fouled with slipper limpets and sorting and gathering heavily infested catches. Loss of habitat for commercially important species may also occur. Oyster and mussel farming may also be affected by fouling, reducing the value of produce and increasing cleaning and handling time. Slipper limpet infestation may also lead to restrictions on movement of stock for growing and selling, leading to loss of revenue.



Source: NBN Gateway

Darwin barnacle, *Austrominius modestus.* PRESENT IN THE SOLENT

Hazard- low

Small barnacle, 5-10mm in diameter, which originates in Australia and is thought to have been introduced to the UK in 1946. It is now widespread throughout the UK and was first documented in Shetland in 1978.

Habitat and Ecology

Hard surfaces in Sheltered bays and estuaries.

Dispersal Potential

Can disperse as larvae (up to 6 days).

Wide temperature and salinity tolerance range, can stay up to 10 days out of water.

Impact The overall economic and environmental impact is thought to be low.

Harpoon weed, *Asparagopsis armata.* PRESENT IN THE SOLENT

Hazard- low

Harpoon weed is endemic to the Southern Hemisphere and thought to originate from Australia and New Zealand. Harpoon weed most likely spread to GB from alien populations already established in Europe, by rafting and drifting on surface currents. It may have been introduced to mainland Europe, where it was first recorded in the Bay of Biscay, France, in 1925 with oyster imports.

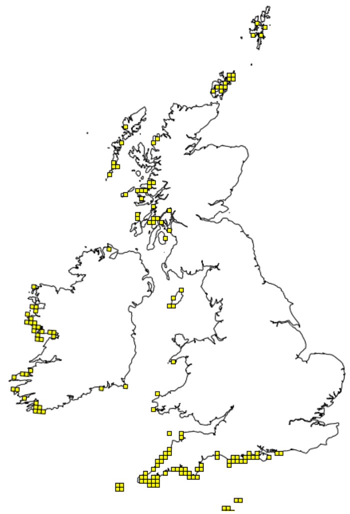
Habitat and Ecology

Sub-littoral growing on hard surfaces. Can spread by spawning or rafting fragment. **Ecological Preferences** Can cope with temperatures from 12 to 21°C and salinity from 35 to 38 ppt; but only tolerate short air exposure.

Environmental Impact

Harpoon weed is reported to dominate algal assemblages in some locations; it forms bloom-like outbreaks and is known to cover 100% of the upper infralittoral during winter in the NW Mediterranean.

Economic impact: Economic losses to fisheries have been reported due to harpoon weed clogging up fishing nets when it occurs in bloom-like outbreaks. In Ireland, harpoon weed has recently been identified as a commercially important species for the production of cosmetics.



Source: NBN Gateway

Green sea-fingers *Codium Fragile.* PRESENT IN THE SOLENT

Hazard- low

Spongy green seaweed with numerous Y-shaped, branching, cylindrical fronds.

Status Widespread in the UK.

Habitat and Ecology

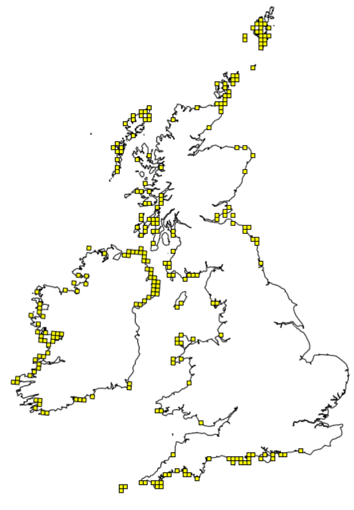
Occurs on rock and coralline algae in pools and on open rock from the mid to lower shore, and in shallow subtidal waters. On sandy or muddy bottoms it attaches to bivalve shells, rocks or artificial structures. It mainly inhabits protected bays and estuaries but also occurs on semi-exposed shores. This algae can tolerate temperature ranges from -2 to 34 °C and salinity ranges from 12 to 40 ppt. It can also tolerate short periods in freshwater and can survive periods of approximately 6 h out of water

Environmental Impact

Has the potential to grow in high densities, dominating canopy communities in rocky shores, displacing the native species *C.tomentosum*.

Economic Impact

It is not yet known if the introduction of *Codium fragile* has resulted in any economic impacts.



Source: NBN Gateway

Appendix 7: Biosecurity Logbook

Date:	
Stock inspection carried out by:	
Water quality: Weather (wind, air temperature, water temperature, precipitations…): O_2: Salinity:	……………………………………………………………………………… ……………………………………………………………………………… ……………………………………………………………………………… ……………………………………………………………………………… ………………………………………………………………………………
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