



New England Fishery Management Council

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**OMNIBUS ESSENTIAL FISH HABITAT AMENDMENT 2
FINAL ENVIRONMENTAL IMPACT STATEMENT**

**Appendix I: Information to support updates to winter flounder EFH
designations**

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Map 11 – New Jersey Ocean Trawl Survey. Black outlined cells show locations that would be designated as adult EFH using the 75% cumulative distribution method, based on catches of juvenile winter flounder year-round. Red line shows the southern boundary preferred by the Council at 39° 22' N 30

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No Action vs. preferred alternative EFH designations

The purpose of this document is to describe the differences between the No Action (Omnibus Habitat Amendment 1, OHA1) and preferred alternative (Omnibus Habitat Amendment 2, OHA2) EFH designations for winter flounder and provide data related to the southern boundary limit of the designations. A thorough understanding of winter flounder habitat use is important because the occurrence of winter flounder EFH, including EFH of eggs, demersal larvae, and early stage juveniles in particular, is often cited as a reason for requiring conservation measures when NMFS conducts EFH consultations on various federally permitted projects in nearshore waters. Generally conservation recommendations take the form of seasonal restrictions on dredging in locations and during time periods when winter flounder eggs, larvae, and newly settled juveniles are expected to be present.

EFH for winter flounder was first designated in Omnibus EFH Amendment 1 in 1999. As with all EFH designations, it consists of text and map elements. Table 1 compares the No Action OHA1 and preferred OHA2 text descriptions. The revised text descriptions incorporate updated scientific information and are more specific with regards to depth, substrates and environmental conditions. One notable addition is the improved description of suitable habitat conditions for eggs and juveniles, including the addition of submerged aquatic vegetation and macroalgae to the list of suitable substrates. The egg text description was also changed to reflect the current scientific understanding that areas with high sedimentation rates may not provide suitable egg habitat. General statements regarding variable factors such as temperature and salinity were removed from the updated text descriptions. Information relating to these variables, as well as other habitat features (including principal prey species) can be found in Appendix B of the OHA2 Final Environmental Impact Statement (FEIS).

The no action designation includes separate but very similar maps for eggs/larvae combined and juveniles/adults combined, based largely on the distribution of adults. The only difference between the two No Action maps is that the southern limit of the egg and larval designations occurs at Delaware Bay, and the southern limit of the juvenile and adult designations occurs at Chincoteague Bay. The preferred alternative has separate maps for eggs and juveniles, and a combined larval and adult map. The No Action and preferred maps are overlaid to show the differences more clearly:

- Map 1 – No Action eggs/larvae vs. preferred eggs
- Map 2 – No Action juveniles/adults vs. preferred juveniles
- Map 3 – No Action adults vs. preferred larvae/adults

Both the No Action and preferred egg maps maintain the same maximum depth in southern New England and the Mid-Atlantic, i.e. 5 meters. Because it is difficult to map the 5 meter depth contour at a broad spatial scale, the map actually extends to 20 meters south of Cape Cod, even though EFH would be limited to 5 meters. Thus, the actual geographic extent of EFH for winter flounder eggs south of Cape Cod would be less than is shown on the map. As part of OHA2, the Council reviewed recent information on egg deposition depth and determined that the 5 m designation remains appropriate. See Volume 2 for details.

Appendix I: Winter flounder EFH

The preferred alternative in OHA2 includes a revision to the southern limit of the winter flounder EFH designation, setting the southern extent of the winter flounder EFH maps for all life stages at 39° 22' N, the approximate latitude of Absecon Inlet (near Atlantic City, NJ). In the NJ Ocean Trawl Survey, fewer winter flounder are captured in the coastal waters of southern New Jersey than in the northern part of the state (see section “Abundance and distribution along the New Jersey coast” on page 24). Consistent with this change, inshore estuaries and embayments south of 39° 22' N latitude were removed from the EFH designations for all four life stages (Table 2). In the No Action designation, these areas were designated based on information in Stone et al. 1994. This report from the Estuarine Living Marine Resource program was used originally to designate the southern NJ estuaries, Delaware Bay, and Chincoteague Bay, but is considered to no longer reflect current conditions of the southern New England stock at the southern end of its range.

Table 1 – No Action vs. preferred OHA2 winter flounder EFH text description

Life stage	No Action OHA1	Preferred OHA2
Eggs	Bottom habitats with a substrate of sand, muddy sand, mud, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the Mid-Atlantic south to the Delaware Bay. Generally, the following conditions exist where winter flounder eggs are found: water temperatures less than 10° C, salinities between 10 - 30‰, and water depths less than 5 meters. On Georges Bank, winter flounder eggs are generally found in water less than 8°C and less than 90 meters deep. Winter flounder eggs are often observed from February to June with a peak in April on Georges Bank.	Sub-tidal estuarine and coastal benthic habitats from mean low water to 5 meters from Cape Cod to Absecon Inlet (39° 22' N), and as deep as 70 meters on Georges Bank and in the Gulf of Maine, and including mixed and high salinity zones in the bays and estuaries listed in table. The eggs are adhesive and deposited in clusters on the bottom. Essential habitats for winter flounder eggs include mud, muddy sand, sand, gravel, and submerged aquatic vegetation. Bottom habitats are unsuitable if exposed to excessive sedimentation which can reduce hatching success.
Larvae	Pelagic and bottom waters of Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. Generally, the following conditions exist where winter flounder larvae are found: sea surface temperatures less than 15° C, salinities between 4 - 30‰, and water depths less than 6 meters. On Georges Bank, winter flounder larvae are generally found in water less than 8°C and less than 90 meters deep. Winter flounder larvae are often observed from March to July with peaks in April and May on Georges Bank.	Estuarine, coastal, and continental shelf water column habitats from the shoreline to a maximum depth of 70 meters from the Gulf of Maine to Absecon Inlet (39° 22' N), including mixed and high salinity zones in the bays and estuaries listed in table. The designation also includes Georges Bank. Larvae hatch in nearshore waters and estuaries or are transported shoreward from offshore spawning sites where they metamorphose and settle to the bottom as juveniles. They are initially planktonic, but become increasingly less buoyant and occupy the lower water column as they get older.

Appendix I: Winter flounder EFH

Life stage	No Action OHA1	Preferred OHA2
Juveniles	<p><i>Young-of-the-Year</i>--Bottom habitats with a substrate of mud or fine grained sand on Georges Bank, the inshore areas of the Gulf of Maine, southern New England and the Mid-Atlantic south to the Delaware Bay.. Generally, the following conditions exist where winter flounder young-of-the-year are found: water temperatures below 28°C, depths from 0.1 - 10 meters, and salinities between 5 - 33‰.</p> <p><i>Age 1+ Juveniles</i>--Bottom habitats with a substrate of mud or fine grained sand on Georges Bank, the inshore areas of the Gulf of Maine, southern New England and the Mid-Atlantic south to the Delaware Bay. Generally, the following conditions exist where juvenile winter flounder are found: water temperatures below 25°C, depths from 1 - 50 meters, and salinities between 10 - 30‰.</p>	<p>Estuarine, coastal, and continental shelf benthic habitats from the Gulf of Maine to Absecon Inlet (39° 22' N), and in mixed and high salinity zones in the bays and estuaries listed in table. The designation also includes Georges Bank. Essential fish habitat for juvenile winter flounder extends from the intertidal zone (mean high water) to a maximum depth of 60 meters and occurs on a variety of bottom types, such as mud, sand, rocky substrates with attached macro algae, tidal wetlands, and eelgrass. Young-of-the-year juveniles are found inshore on muddy and sandy sediments in and adjacent to eelgrass and macroalgae, in bottom debris, and in marsh creeks. They tend to settle to the bottom in soft-sediment depositional areas where currents concentrate late-stage larvae and disperse into coarser-grained substrates as they get older.</p>
Adults	<p>Bottom habitats including estuaries with a substrate of mud, sand, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England and the middle Atlantic south to the Delaware Bay. Generally, the following conditions exist where winter flounder adults are found: water temperatures below 25° C, depths from 1 - 100 meters, and salinities between 15 - 33‰.</p>	<p>Estuarine, coastal, and continental shelf benthic habitats extending from the intertidal zone (mean high water) to a maximum depth of 70 meters from the Gulf of Maine to Absecon Inlet (39° 22' N), and in mixed and high salinity zones in the bays and estuaries listed in table. The designation also includes Georges Bank. Essential fish habitat for adult winter flounder occurs on muddy and sandy substrates, and on hard bottom on offshore banks. In inshore spawning areas, essential fish habitat includes a variety of substrates where eggs are deposited on the bottom (see eggs).</p>
Spawning adults	<p>Bottom habitats including estuaries with a substrate of sand, muddy sand, mud, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England and the Mid-Atlantic south to the Delaware Bay. Generally, the following conditions exist where winter flounder adults are found: water temperatures below 15° C, depths less than 6 meters, except on Georges Bank where they spawn as deep as 80 meters, and salinities between 5.5 - 36‰. Winter flounder are most often observed spawning during the months February - June.</p>	<p>No separate spawning adult designation for winter flounder or any other species in OHA2.</p>

Table 2 – Estuaries and embayments EFH designation for winter flounder. Designations adjusted in OHA2 indicated with cell shading and strikethrough.

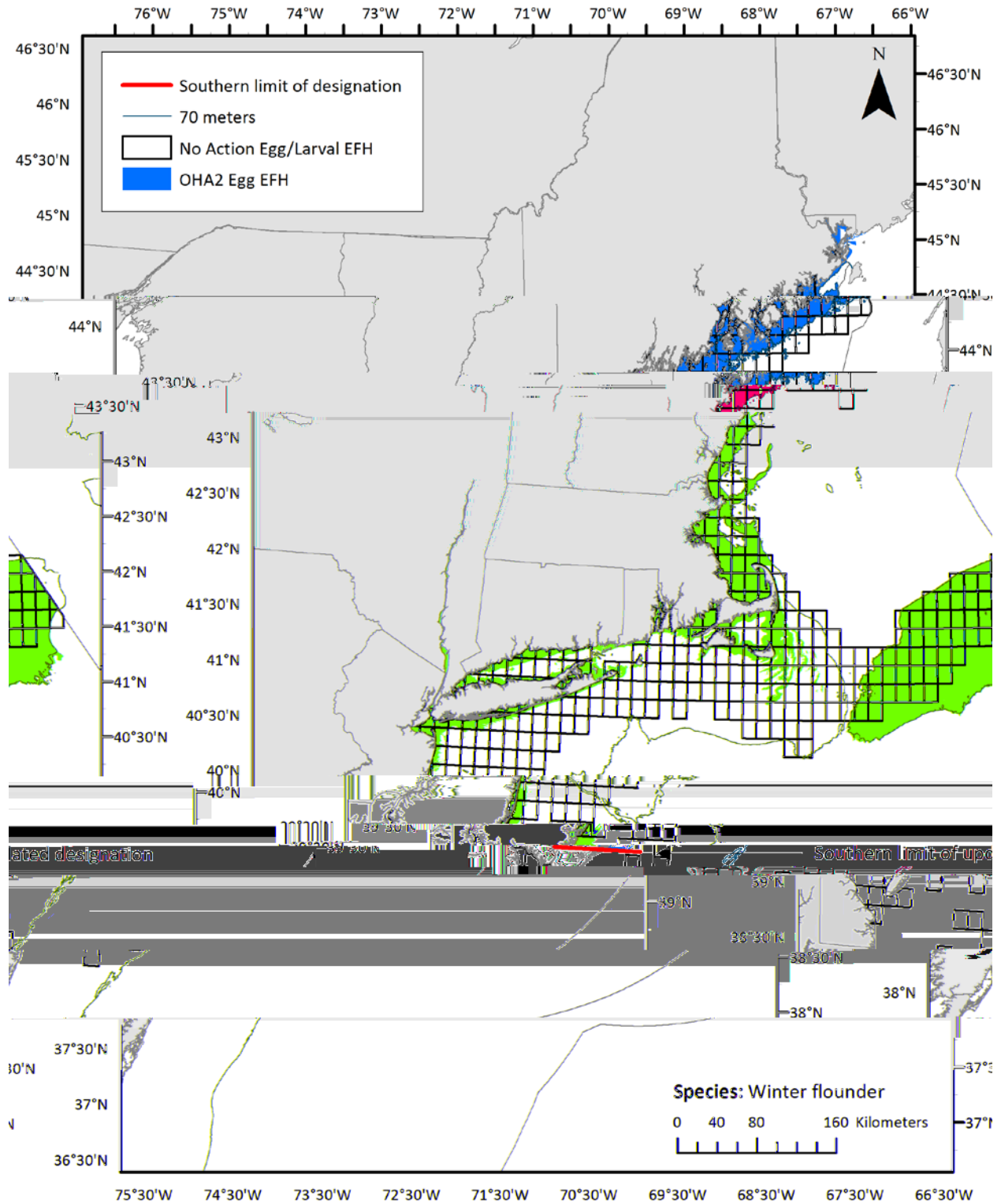
Estuaries and Embayments	Eggs	Larvae	Juveniles	Adults	Spawning Adults
Passamaquoddy Bay	m,s	m,s	m,s	m,s	m,s
Englishman/Machias Bay	m,s	m,s	m,s	m,s	m,s
Narraguagus Bay	m,s	m,s	m,s	m,s	m,s
Blue Hill Bay	m,s	m,s	m,s	m,s	m,s
Penobscot Bay	m,s	m,s	m,s	m,s	m,s
Muscongus Bay	m,s	m,s	m,s	m,s	m,s
Damariscotta River	m,s	m,s	m,s	m,s	m,s
Sheepscot River	m,s	m,s	m,s	m,s	m,s
Kennebec / Androscoggin Rivers	m,s	m,s	m,s	m,s	m,s
Casco Bay	m,s	m,s	m,s	m,s	m,s
Saco Bay	m,s	m,s	m,s	m,s	m,s
Wells Harbor	m,s	m,s	m,s	m,s	m,s
Great Bay	m,s	m,s	m,s	m,s	m,s
Hampton Harbor*	m,s	m,s	m,s	m,s	
Merrimack River	m	m	m	m	m
Plum Island Sound*	m,s	m,s	m,s	m,s	
Massachusetts Bay	s	s	s	s	s
Boston Harbor	m,s	m,s	m,s	m,s	m,s
Cape Cod Bay (seawater zone only in OHA2)	m,s	m,s	m,s	m,s	m,s
Waquoit Bay	m,s	m,s	m,s	m,s	m,s
Buzzards Bay	m,s	m,s	m,s	m,s	m,s
Narragansett Bay	m,s	m,s	m,s	m,s	m,s
Long Island Sound	m,s	m,s	m,s	m,s	m,s
Connecticut River	m	m	m	m	m
Gardiners Bay	m,s	m,s	m,s	m,s	m,s
Great South Bay	m,s	m,s	m,s	m,s	m,s
Hudson River / Raritan Bay	m,s	m,s	m,s	m,s	m,s
Barneгат Bay	m,s	m,s	m,s	m,s	m,s
New Jersey Inland Bays (OHA2 no designation south of 39° 22' N)	m,s	m,s	m,s	m,s	m,s
Delaware Bay (removed OHA2)	m,s	m,s	m,s	m,s	m,s
Delaware Inland Bays (removed OHA2)	m,s	m,s	m,s	m,s	m,s
Maryland Inland Bays* (removed OHA2)			m,s	m,s	
Chincoteague Bay (removed OHA2)			s	s	

S ≡ The EFH designation for this species includes the seawater salinity zone of this bay or estuary (salinity > 25.0‰).

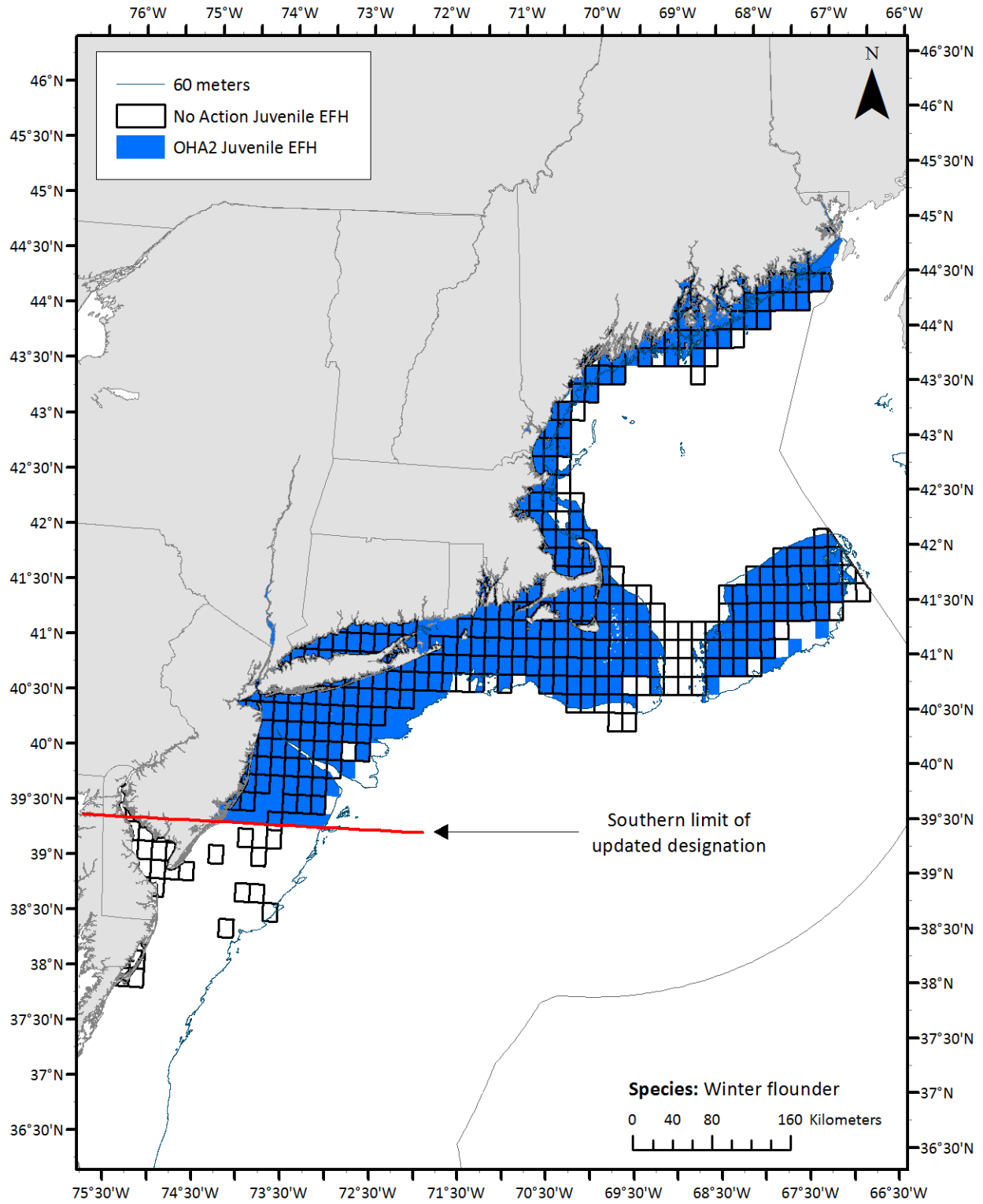
M ≡ The EFH designation for this species includes the mixing water / brackish salinity zone of this bay or estuary (0.5 < salinity < 25.0‰).

* = This water body was not included in the original ELMR reports, but it was included in the salinity zone maps that were appended to all the relevant fishery management plans and amendments which implemented the no action EFH designations; EFH designations were inferred in these locations if there were ELMR-based designations in the adjacent north and south locations.

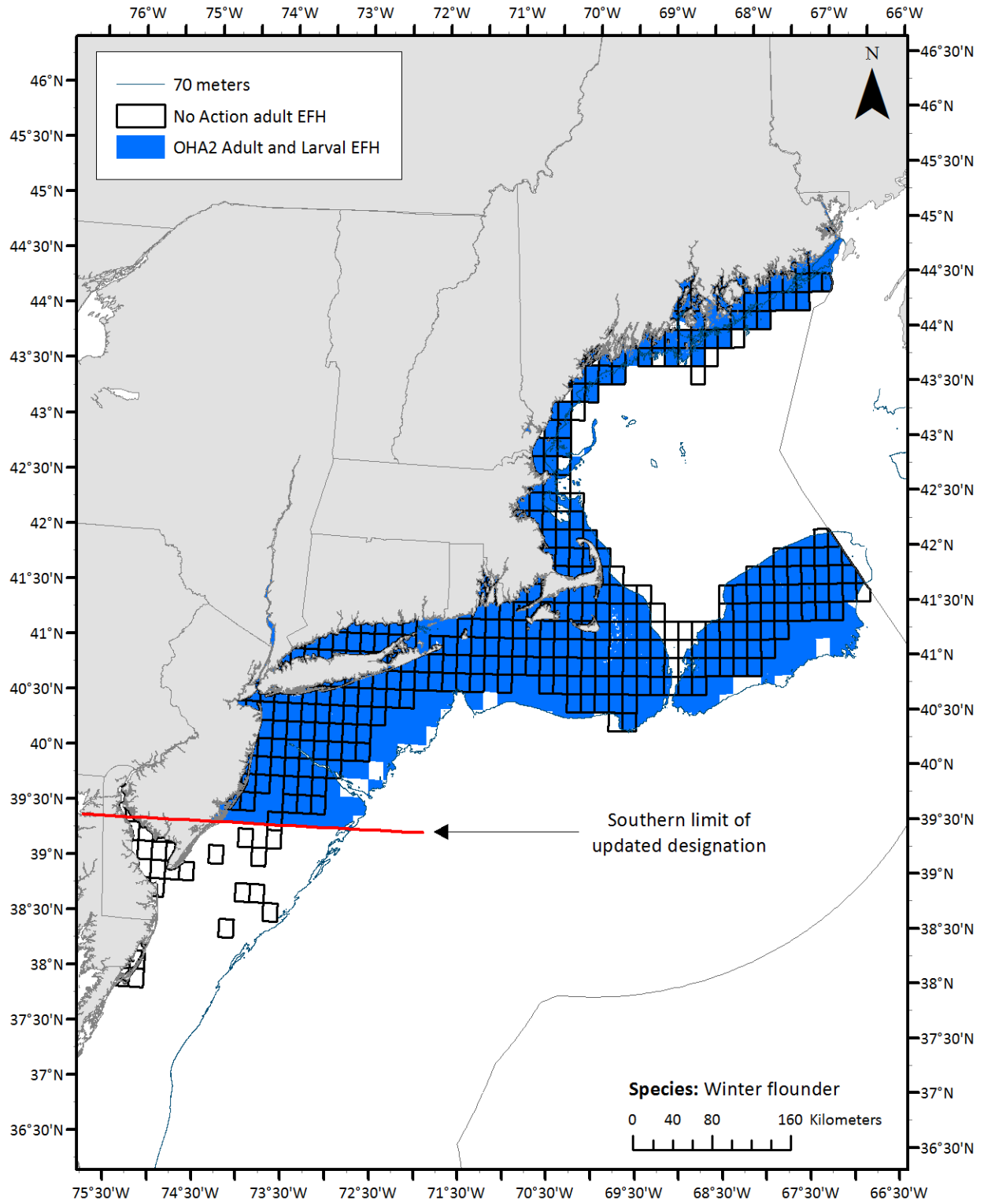
Map 1 – No Action vs. preferred alternative EFH designation maps – eggs



Map 2 –No Action vs. preferred alternative EFH designation maps – juveniles



Map 3 – No Action vs. preferred alternative EFH designation maps – adults and larvae



Scientific literature on habitat use of Southern New England/Mid-Atlantic winter flounder

This section summarizes published information relating to the suitability of estuarine and nearshore habitats for winter flounder eggs, larvae, and young-of-the-year juveniles in the New Jersey-New York-Connecticut region, and the factors that affect spawning, egg survival, and juvenile settlement, growth, and survival, particularly in the first few weeks after settlement when the juveniles are less mobile and more vulnerable to disturbance. Locations related to the studies are shown in Map 4 (NY harbor), Map 5 (northern NJ) and Map 6 (southern NJ).

Summary

Under the No Action designations from Omnibus EFH Amendment 1, the southern extent of the juvenile and adult EFH designations was Chincoteague Bay, which is approximately 90 miles south of Absecon Bay. The southern limit of the egg and larval designations was Delaware Inland Bays, approximately 50 miles south of Absecon Bay. According to two published analyses of trawl survey data, winter flounder are more abundant within northern New Jersey estuaries and coastal waters as compared to southern New Jersey (Scarlett 1991, Wuenschel et al. 2009). Maps prepared for this appendix using data from the New Jersey Ocean Trawl Survey (1988-2014) confirm these results. Catch rates of winter flounder were highest in northern NJ with a distinct drop in abundance at Great Bay and the remaining southern NJ regions. Infrequent catches of low numbers of juveniles do occur in Delaware Bay trawl surveys (see the section “Winter flounder catches in Delaware Bay” on page 32). Recent catches in Delaware Bay have been low relative to the survey time series.

- **Adult and spawning habitats:** In the mid-Atlantic Bight, adult winter flounder move offshore during the summer when inshore water temperatures are high, then back into bays and estuaries during winter and early spring to spawn (Phelan 1992, Scarlett and Allen 1992). Spawning occurs in inshore estuaries and coastal waters from January through March in New Jersey and New York/Newark harbor (Scarlett and Allen 1989, Wuenschel et al. 2009, Wilber et al. 2013). What is known about spawning habitats can be inferred from the following summary of information relating to egg habitats.
- **Egg habitats:** Observations or field surveys of winter flounder egg habitats in the southern New England-Middle Atlantic region have been conducted in Rhode Island coastal ponds (Crawford 1990), in Milford Harbor, Connecticut (Schultz et al. 2007), in New York/Newark harbor (Wilber 2013) and in several northern New Jersey estuaries (Scarlett and Allen 1989 and Scarlett 1991, as reported in Pereira et al. 1999). The results of one laboratory study on the effects of burial on egg survival (Berry et al. 2011) are also summarized here.

In the upper and lower bays of New York harbor (Map 4), egg densities were higher in shallow water (<3.5 m) than in deeper (12 m) shipping channels, except during years with severe winters or when bottom disturbance (e.g., from tidal currents) was extreme (Wilber et al. 2013). Also, recently-spawned early stage eggs were present at shallow, non-channel stations (average depth 5.3 m) on sand, but not in slightly deeper (7.9 m)

non-channel stations with more silt and clay. Scarlett and Allen (1989) collected winter flounder eggs in the Manasquan River in February and March 1985 at salinities ranging from 14 to 32 ppt, temperatures of 0.9 to 10°C, and depths of 2 to 4.5 m (Pereira et al. 1999). In a subsequent study (Scarlett 1991), eggs were collected in the Shrewsbury and Navesink rivers in temperatures of 4-7.5°C, salinities of 14-22 ppt, and depths of 2-4 meters. The results of several lab studies of the effects of temperature and salinity on egg viability and hatching times are summarized in Pereira et al. (1999). A more recent lab study (Berry et al. 2011) showed that burial of eggs under excessive amounts of sediment such as can be produced near dredging sites reduces egg survival and prolongs hatching times. It was not clear what the depth of sediment would have to be for the effect to be significant, but since the eggs are very small (<1 mm in diameter) and attached to the bottom, they are clearly susceptible to high sedimentation rates. Overall, the literature supports designation of egg EFH for winter flounder in shallow waters.¹

- **Larval and early juvenile habitats:** Winter flounder larvae are initially planktonic but become increasingly bottom-oriented as they approach metamorphosis and settle to the bottom as juveniles about eight weeks after hatching (Pereira et al. 1999). Larvae are abundant in the Great Bay-Little Egg Harbor estuary from mid-March to June (Able and Fahay 2010) and were collected in the Shrewsbury and Navesink rivers from February through April at depths of 2 to 6 m (Scarlett 1991). Settlement occurs after metamorphosis during March-May at a length of about 10 mm and, in the vicinity of Little Egg Inlet occurs predominantly within small coves just inside the inlet (Chant et al. 2000, Able and Fahay 2010). In a 1996/1997 study, dispersal from the cove at Little Egg Harbor took place shortly after settlement, suggesting that pelagic juveniles use these coves as settlement areas, but they are not juvenile nursery habitats. In a 1994-1996 study, density of juveniles on the seabed peaked in late May to early June, then density decreased substantially within six days (Curran et al. 2000). In a 1990 study, juveniles settled in the Navesink River between mid-April and mid-May and in Sandy Hook Bay May through mid-June (Manderson et al. 2003).
- **Juvenile habitat:** New Jersey estuaries, particularly in the more northern part of the state, provide suitable habitat for juvenile winter flounder. Goldberg et al (2002) compared three estuaries, finding the highest abundance of young-of-the-year (YOY) juvenile winter flounder in the Navesink River (north of marker 109 on Map 5), with significantly lower and more variable abundance in Great Bay-Little Egg Harbor (Map 5) and in the Hammonasset River (which is located approximately halfway up the Connecticut coast, between New Haven and New London). Densities of YOY juveniles collected for a growth study during 1990-1999 were typically highest in Sandy Hook Bay, lowest in Great Bay, with intermediate catch rates at Wildwood in southern NJ (Sogard et al. 2001).

¹ An expansion of the winter flounder egg EFH designation from a maximum depth of 5 meters to a maximum depth of 20 meters was considered by the Council during development of OHA2, but is not supported by these data. The information obtained during the long-term study of winter flounder eggs, larvae, and adults in the NY and NJ harbor area was presented to the Habitat Plan Development Team on March 26-27, 2009.

Appendix I: Winter flounder EFH

Juvenile winter flounder remain in shallow-water habitats for most of their first year of life, migrating into deeper water in the fall as nearshore water temperatures decline (Able and Fahay 2010). Recently metamorphosed juvenile winter flounder are more likely to settle to the bottom in areas of low current velocity with fine sediments, but older YOY juveniles can be found on a variety of substrates (Curran and Able 2002, Chant et al. 2000, Stoner et al. 2001). Juveniles >25 mm in length in the Great Bay-Little Egg Harbor estuary are found over a variety of habitat types, regardless of sediment or structure, but most are in shallow water (1-3 m) over sandy substrates at depths <1 meter (Able and Fahay 2010). Howell et al. (1999) showed that YOY juveniles in Connecticut estuaries (depths < 5.5 m) were more abundant on muddy sediments with debris (shells, wood, leaves) or live bivalves than on sand. Analysis of catch data from New Jersey's Navesink River indicated that the probability of capturing recently settled juveniles was high on medium- to coarse-grained sand (mean diameter 0.5 mm), while slightly larger YOY juveniles were least likely to be collected on fine sediments and were most common on coarse to very coarse sand (mean diameter 1 mm, Phelan et al. 2001). Laboratory studies showed that smaller individuals (<40 mm SL) preferred to bury under fine-grained sediments, while larger individuals (40 mm SL) preferred coarse-grained sediments.

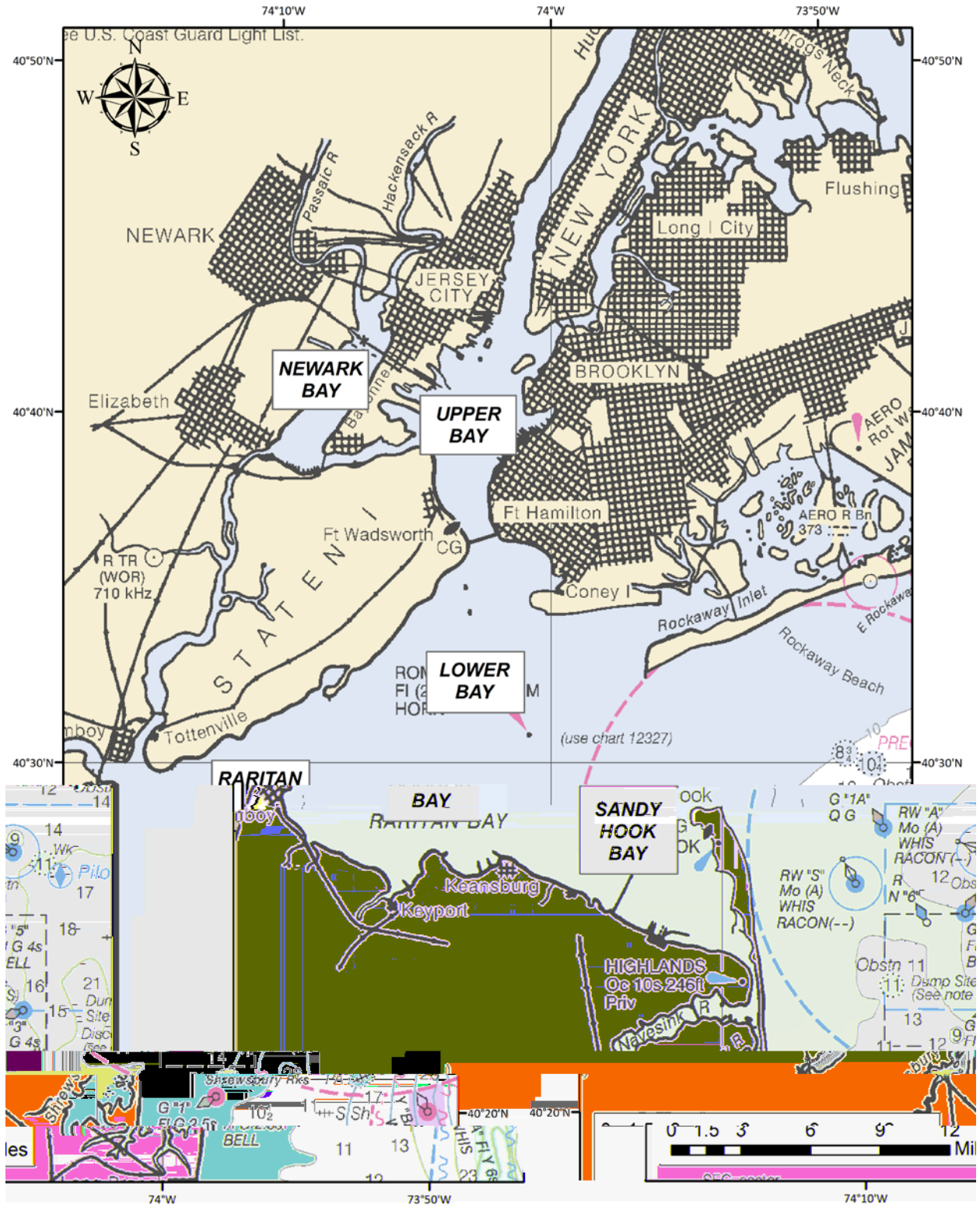
Habitat association models for newly settled juveniles in Navesink River-Sandy Hook Bay estuarine system revealed that fish <25 mm occupied deep (maximum 12 m) depositional environments and either moved into shallower water (2-3 m) as they got older, or were more abundant in shallow water because the fish in deeper water are more prone to predation (Stoner et al. 2001, Manderson et al, 2004). For 25-55 mm juveniles, the abundance of prey organisms was also a significant factor. These results indicated that juvenile nursery habitats are dynamic – expanding, contracting, and shifting position with changes in key environmental variables.

In summary, in order to protect habitats that are essential for eggs, larvae, and early stage juveniles, adverse impacts should be minimized on a seasonal basis within the southern New England-Middle Atlantic region from January through June. This covers the maximum time period of egg deposition and development the larval phase, and the settlement and presence of early stage juveniles, accounting for seasonal variations in temperature that produce inter-annual variations in the timing of habitat use.

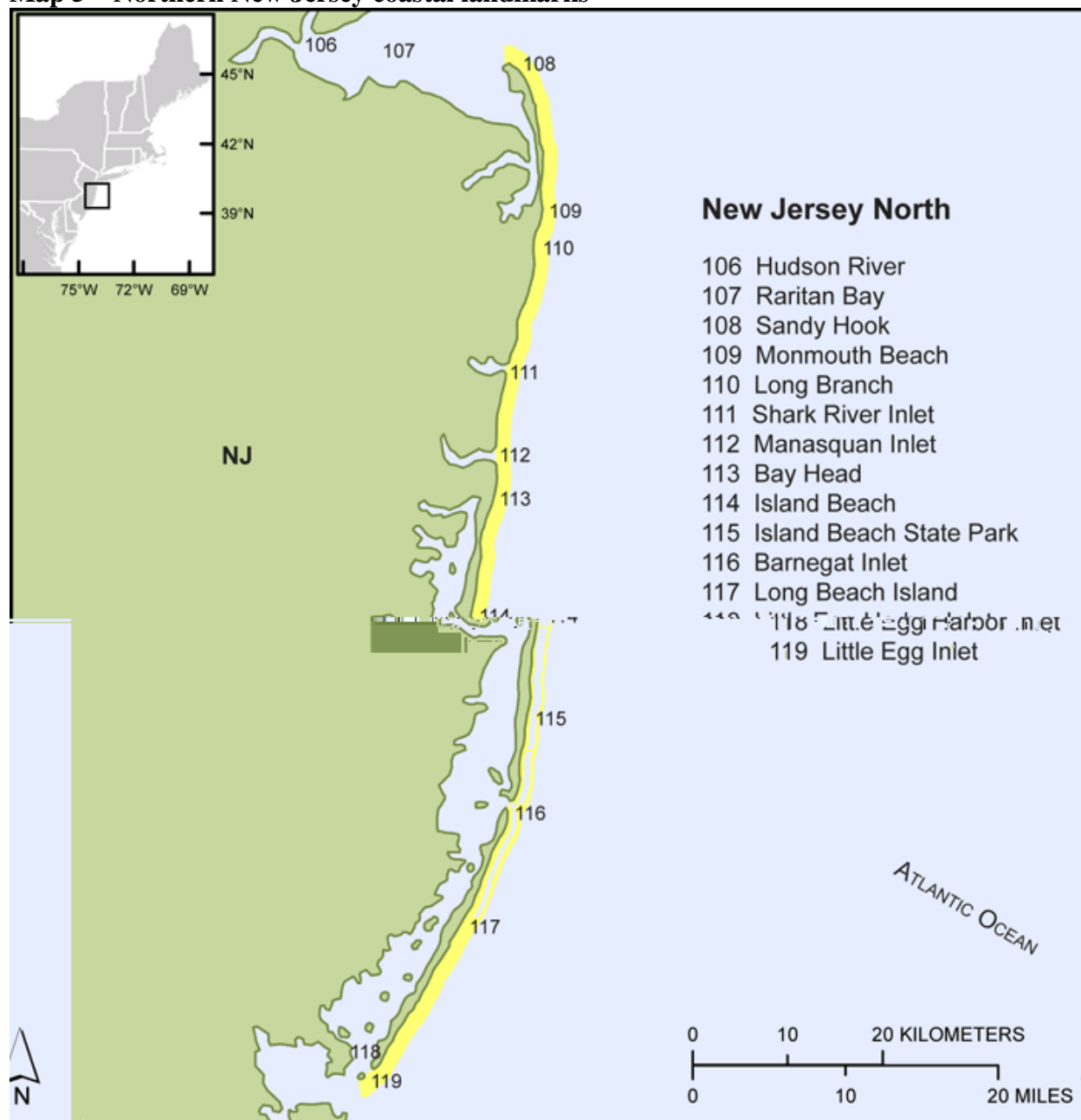
Details of individual studies

This section provides additional details on the studies cited above. Locations related to the studies are shown in Map 4 (NY harbor), Map 5 (northern NJ) and Map 6 (southern NJ).

Map 4 – New York Harbor and surrounds

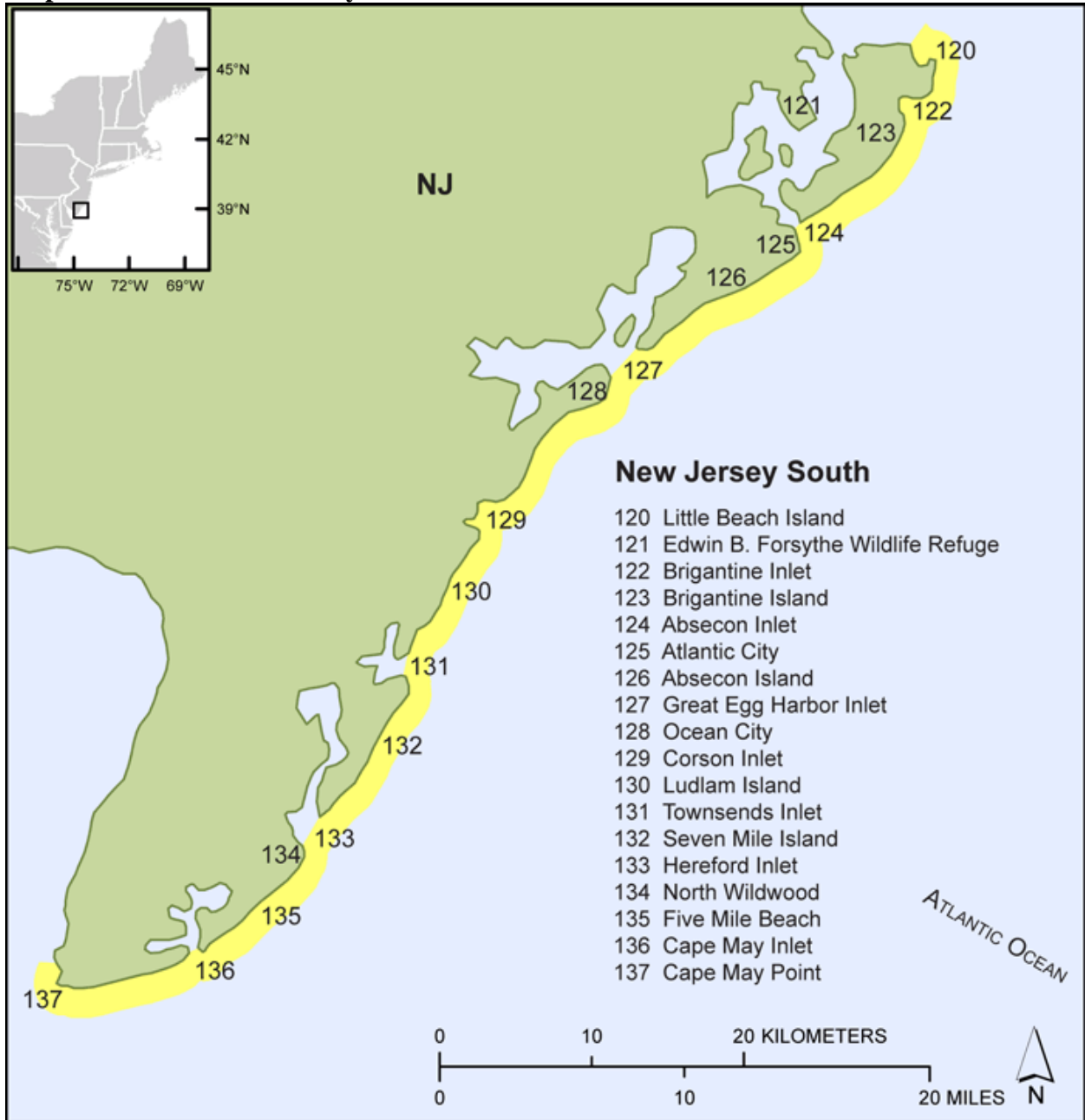


Map 5 – Northern New Jersey coastal landmarks



Basemap: Medium Resolution (1:70,000 scale) Digital Vector Shoreline of the coterminous United States, 1994. National Oceanic and Atmospheric Association.

Map 6 – Southern New Jersey coastal landmarks



Basemap: Medium Resolution (1:70,000 scale) Digital Vector Shoreline of the coterminous United States, 1994. National Oceanic and Atmospheric Association.

Able and Fahay (2010): Ecology of Estuarine Fishes, Chapter 100: *Pseudopleuronectes americanus* (Walbaum) – Winter Flounder.

- Location: Great Bay-Little Egg Harbor estuary, NJ
- Winter flounder larvae abundant in (1988-2007) mid-March to June and appeared to vary with water temperature during the period of spawning and egg development
- Young-of-the-year (YOY) juveniles settle to the bottom March through May at a length of about 10 mm (or 1 cm); modal lengths increase steadily through the summer and fall, ranging from about 6 cm in June to about 13 cm in Nov. Growth slows during Nov-Dec as YOY migrate from estuarine to ocean habitats.
- Juveniles >25 mm at this location occur across a variety of habitat types, regardless of sediment and structure, but most are in shallow water (1-3 m) over sandy substrates; in very shallow habitats (<1 m), YOY are most common over unvegetated substrates.

Berry et. al. (2011 Technical Conference): Dredging Effects on Winter Flounder.

- A study conducted to test the effects of sediment cover on survival and hatching time of recently spawned eggs (3-5 days after fertilization). Lab test with different sediment treatments (depths of 0.02-10 mm) against a control treatment (no sediment). Three experiments ran from 18-34 days in length. Eggs averaged 0.75 mm in diameter.
- Results were variable between experiments. Hatching success was reduced by 0.6 mm of sediment in all three experiments, but not significantly. Percent hatch in the two experiments that tested for sediment depths greater than 2.5 mm were <1%. Hatching times were significantly longer at sediment depths of 0.6 and 1.2 mm compared to eggs in the control.
- The range of burial depths tested in this study fell within the range of natural sediment deposition events observed on short-term time scales in Narragansett Bay and other estuarine and coastal systems (approx. 0.1 mm/day, or 1.4 mm over a two week egg incubation period). Under certain conditions, dredging activity would produce much higher sediment loads which could severely reduce egg survival rates.

Chant et. al. (2000): Delivery of winter flounder (*Pseudopleuronectes americanus*) larvae to settlement habitats in coves near tidal inlets.

- Location: Little Egg Harbor, NJ
- Observations of larval winter flounder in Little Egg Harbor show that juvenile winter flounder settle to the bottom in the inlet's coves in March through June.
- A survey of the area in 1996 and 1997 indicated that larval abundance peaked in May.
- Based on hydrodynamic surveys of the region, a mechanism is suggested by which larvae are delivered to coves immediately inside of tidal inlets for subsequent settlement. The mechanism involves the filling of the coves just inside the inlet during flood tide.

Curran et. al. (2002): Annual stability in the use of coves near inlets as settlement areas for winter flounder.

- Location: Coves near Little Egg Harbor (southern NJ).
- Juvenile winter flounder were sampled in spring and early summer 1994-1996

- Peak densities of recently-settled fish (10-45 mm TL) occurred in late May to early June, and declined soon afterwards, usually by late June to early July
- Dispersal from the cove took place shortly after settlement, suggesting that winter flounder use these coves as settlement areas, but not as nursery habitats.
- Growth rates were higher for WF that settled earlier in the season (early-June to mid-June) than later (mid- to late-June).

Goldberg et al. (2002): Variability in habitat use by young-of-the-year winter flounder, *Pseudopleuronectes americanus*, in three northeastern U.S. estuaries.

- Locations: Hammonasset estuary (CT), Navesink River (northern NJ), and Great Bay-Little Egg Harbor (southern NJ).
- YOY juveniles sampled in five different habitat types every two weeks with a small beam trawl, May-Oct, 1995 and 1996.
- Abundance of YOY winter flounder was highest in the Navesink River estuary and similar between years, but was significantly lower and differed between years in the Great Bay-Little Egg Harbor and Hammonasset River estuaries.
- Where habitat-related differences in abundance were significant, YOY were found in higher densities in unvegetated areas adjacent to eelgrass. The exception was in the Hammonasset River in 1995 when densities were higher in eelgrass.

Howell et al. (1999) Juvenile winter flounder distribution by habitat type

- Location: Five estuaries along the CT shoreline of Long Island Sound – Thames River, CT River, Clinton harbor, New Haven harbor, and Housatonic River
- YOY juveniles were collected in a small beam trawl monthly June-Sept 1990 and seasonally June, July-Aug, and Oct-Nov 1991-1993. Each sampled embayment was bounded landward by transition to <5 ppt salinity and seaward headland to headland at approx. 5.5 m depth (at MLW).
- The only habitat feature that correlated with abundance was sediment type (not salinity, water temperature, water column turbidity, depth interval, channel/non-channel, or the presence of sea lettuce, *Ulva lactuca*)
- Highest densities within a site most often occurred in mud/shell-litter habitat, followed by mud/wood-litter [leaves] and mud/no litter habitat; sandy sites with or without litter yielded the lowest densities.

Manderson et al. (2002): Spatial dynamics of habitat suitability for the growth of newly settled winter flounder *Pseudopleuronectes americanus* in an estuarine nursery.

- Location: Navesink River/Sandy Hook Bay estuarine system, New Jersey.
- The relationship between the growth of early juvenile winter flounder and the spatial dynamics of estuarine gradients immediately following larval settlement was examined using field enclosure techniques, mid-May through June, 1999
- Generalized additive modeling indicated that growth was most rapid at relatively cool temperatures (<21°C) and low salinities (<24ppt). However, spatial analysis indicated that the relative influences of temperature and salinity changed over time.

Manderson et al. (2003): Winter flounder settlement dynamics and the modification of settlement patterns by post-settlement processes in a NW Atlantic estuary.

- Location: Navesink River/Sandy Hook Bay estuarine system, New Jersey.
- From April through June 2000, distributions of settling and early juvenile winter flounder were measured to examine how pre- and post-settlement processes determine the location of the primary nursery ground.
- Fish settled on organically rich substrata (organic content = 5 to 12% by weight) in the Navesink River (mid-April through mid-May) and in Sandy Hook Bay (May through mid-June).

Manderson et al. (2004): Shallow water predation risk for a juvenile flatfish (winter flounder; *Pseudopleuronectes americanus*, Walbaum) in a northwest Atlantic estuary

- Location: Navesink River – Sandy Hook Bay estuarine system
- Field surveys and tethering experiments to determine the importance of shallow habitats as refuges for juvenile winter flounder from predation.
- As fish increased in size, depth of occurrence gradually decreased so that fish <35 mm were concentrated in depths of about one meter.
- Predation risk (e.g., from summer flounder) for 30-50 mm fish was low in shallow water and increased rapidly with depth.

Nye et al. (2009): Changing spatial distribution of fish stocks in relation to climate and population size on the Northeast United States continental shelf.

- Location: Gulf of Maine, Georges Bank, Southern New England, Mid-Atlantic Bight
- The study evaluates the impact that increased warming waters have had on 36 managed U.S. fish stocks, including winter flounder. NMFS spring trawl survey data from 1968-2007 was used to observe changes in distribution using the center of biomass as an indicator for shifts in species distribution over a long time series.
- Results show that the center of biomass shifted southward for the northern stock of winter flounder, which is opposite to the expected response to warming ocean temperatures. There is a lot of inter-annual variability and no clear temporal trend for the southern stock.

Phelan et. al. (2000): Estuarine and habitat-related differences in growth rates of young-of-the-year winter flounder (*Pseudopleuronectes americanus*) and tautog (*Tautoga onitis*) in three northeastern US estuaries.

- Locations: Great Bay–Little Egg Harbor (southern NJ), Navesink River (northern NJ), and Hammonasset River (CT).
- Field caging experiments in 1994 and 1995 to compare growth in several habitat types that included eelgrass, macroalgae, and marsh creeks. Controlled variables included temperature range, salinity range, and tidal range. Growth rate was used as an indicator of habitat quality for YOY winter flounder across estuaries, years, and habitat type.
- Results demonstrated that growth rates varied based on habitat type, estuary, and year. Authors concluded that it was difficult to evaluate habitat quality based on differences in growth rate.

Phelan et. al. (2001): Size-related shifts in the habitat associations of young-of-the year winter flounder (*Pseudopleuronectes americanus*): field observations and laboratory experiments with sediments and prey.

- Location: Navesink River–Sandy Hook Bay estuary
- Field surveys and lab experiments to determine the role of substrata in habitat selection by YOY winter flounder.
- Winter flounder and sediment samples were collected in May and July 1997. Sediment size included muddy sand, fine sand, coarse sand, fine gravel, and gravel.
- Analysis of field data (general additive model) indicated a higher probability of capturing 10-49 mm juveniles on medium to fine-grained sand and larger juveniles (15-69 mm) on coarse sand.
- Lab studies showed that smaller fish (<40 mm) preferred fine-grain sediment and larger individuals (>40 mm) preferred larger grain sizes, while fish 50-59 mm preferred coarse sand sediments, and fish 60-69 mm were associated with all three sand size classes; gravel was not selected by either small or large juveniles.
- Burying ability increased with size and all fish avoided sediments that prevented burial.

Scarlett (1991): Relative abundance of winter flounder (*Pseudopleuronectes americanus*) in Nine Inshore Areas of New Jersey.

- Location (N-S): Shark R., Manasquan R., Toms R., Double Creek Channel, Little Egg Harbor, Great Bay, Great Egg Harbor Bay, Sea Isle/Avalon, and Wildwood/Cape May.
- Two five minute tows at three stations at each site on a monthly basis Nov 1987-April 1988 with a 4.9 m semi-balloon otter trawl with a 6.4 m footrope and 3.8 cm stretched mesh in the cod end.
- 380 fish caught, mostly juveniles between 10 and 35 cm, very few YOY juveniles.
- Numbers per tow = 4-4.5 at two northern-most sites, 0.2-1.5 at next three sites, and less than or equal to 0.1 at four southern-most sites.

Schultz, et al. (2007): Determining winter flounder spawning sites in two Connecticut estuaries

- Location: New Haven and Milford harbors, Long Island Sound
- Unsuccessful acoustic seabed sediment mapping but soft sediments, hard sediments (sand), rippled sand, and shell hash present in video ground-truth stations
- Eggs collected using a demersal plankton net attached to an epibenthic sled at random stratified stations during February, March, and April. Depths sampled 1-2 m, 2-4 m, 4-6 m, >6 m; stations classified as inner vs. outer harbor and current speed was mapped
- Most of the eggs were collected in late March, with higher collection rates in the outer harbor areas
- Variation in number of eggs collected by depth and sediment type was not significant. However, low flow rates appeared to be an important determinant of egg abundance, with no eggs collected in high flow areas.

Sogard et. al. (2001): Long-term assessment of settlement and growth of juvenile winter flounder (*Pseudopleuronectes americanus*) in New Jersey estuaries

- Locations: Sandy Hook, Barnegat Bay, Great Bay, and Wildwood (listed from northern- to southern-most estuary)
- Study to examine patterns of metamorphosis, settlement, and growth of YOY juveniles over a ten year period in four NJ estuaries.
- Analysis of otoliths from newly settled winter flounder collected on unvegetated substrates with similar depths and sediment types (<1 m at low tide, primarily sand) at all sites from late May to early June 1990-1999 with a beach seine.
- Densities varied across sites, was typically lowest at Great Bay and highest at Sandy Hook; inter-annual trends were not consistent among sites.
- There was a high level of consistency in spatial patterns among estuaries, but there were consistent temporal patterns in the timing of metamorphosis, which was delayed in colder years at all sites.
- Juveniles collected at Sandy Hook metamorphosed later than juveniles at other sites and had faster growth rates than at the two mid-coast sites. Results suggest that the timing of settlement is driven by large-scale climatic factors; however, interannual variability in densities and growth rates were more site-specific, indicating control by local environmental factors.

Stoner et. al. (2001). Spatially explicit analysis of estuarine habitat for juvenile winter flounder: combining generalized additive models and geographic information systems.

- Location: Navesink River/Sandy Hook Bay estuarine system.
- Spatially-explicit models of habitat association on newly settled juveniles developed from seasonal beam trawl surveys from 1996 to 1998.
- Modeling revealed that the distribution of juveniles <25 mm in length in the spring was associated with low temperature (<16°C) and high sediment organic content, placing them in deep, depositional environments (maximum depth 12 m).
- Larger fish (25-55 mm) were associated with high sediment organics, shallow depth (<3 m), and salinity near 20 ppt.
- The largest size class (56-138 mm) was associated with shallow depths (<2 m), temperature near 22°C, and the presence of macroalgae.
- The abundance of prey organisms was a significant factor for fish 25 to 55 mm in length, but not for fish >55 mm.
- Results indicate that nursery habitats are dynamic – expanding, contracting, and shifting position with changes in key environmental variables.
- Study concluded that habitat associations do not necessarily indicate habitat preference. In addition, growth rates and survivorship would be more helpful indicator for habitat preferences. This study did test and proved correlation between abundance and environmental factors; but, cannot definitively state that the variations in abundance is actually due to the different environmental conditions, whether coupled with other environmental parameters or not.

Wilber et. al. (2013): Identification of Winter Flounder (*Pseudopleuronectes americanus*) Estuarine Spawning Habitat and Factors Influencing Egg and Larval Distributions.

- Location: Arthur Kill/Newark Bay, Lower Bay, and Upper Bay between New York and New Jersey.
- Data from long-term biological surveys (mid-January to mid-June, 2002-2011) in the NY-NJ harbor and lower bay area was used to relate the spatial and temporal distribution of winter flounder eggs and larvae with environmental factors. Eggs and larvae were collected in epibenthic sleds equipped with plankton nets.
- Starting in 2008, non-viable as well as viable eggs were counted and early to late stages of development were noted. Early stage eggs are more likely to be found near spawning locations than late stage eggs which have a higher probability of being transported to new locations.
- Results showed that spawning season began mid-January for some years, and February or March in other years. There was no correlation between initial egg presence and temperature. During years with severe winters, 50% of eggs were collected in late March versus early March for years with moderate winters.
- Egg densities were consistently higher in the upper and lower bays of the harbor than in Newark Bay and the Arthur Kill (between Staten Island and the NJ shoreline).
- Throughout the harbor, egg densities were much higher in shallower non-channel areas (average 3.5 m) compared to channel areas (12 m) during years with moderate winters. In cold years, egg densities were similar in non-channel and channel habitats.
- Egg densities were higher at non-channel locations than in the channels during weak tidal phases, but not during strong tidal phases. Most of the early stage eggs collected in channels in 2011 were collected during a period of extreme spring tides and flooding in the Hudson River.
- These results indicate that winter flounder in the NY-NJ harbor area spawn in shallow estuarine habitat and that spawning site selection is non-random.
- In the lower bay, early stage eggs were collected at non-channel stations with an average depth of 5.3 m where the substrate was predominantly sand (96.5%); in slightly deeper water (average 7.9 m) where there was more silt and clay, no early stage eggs were found.

Wuenschel et. al. (2009): Seasonal patterns of winter flounder *Pseudopleuronectes americanus* abundance and reproductive condition on the New York Bight continental shelf.

- Location: New York Bight from entrance to NY harbor to Delaware Bay
- Data collected from New Jersey coastal trawl survey in October 2006 and January, April, June, August and October 2007.
- Winter flounder were most abundant in northern NJ waters during all six sampling periods, with the highest catches at the northernmost stations in 5 of the 6 sampling periods; abundance was high in January, April, and June but greatest in April; nearly all fish caught were large juveniles or adults.
- The occurrence of ripening individuals on the inner continental shelf in January suggests that these fish either rapidly move into estuaries to spawn by February–March or they remain on the inner shelf to spawn, or some combination of these.

- Biological information from Navesink River in March using an otter trawl was also used. Observations indicate increased feeding activity following spawning, which would help improve gonad production in the following year.
- Study period may be too short to conclude reliable seasonal observations.

Abundance and distribution along the New Jersey coast

The New Jersey Department of Environmental Protection has conducted a stratified random bottom trawl survey in NJ coastal waters five times per year since 1988. Tows last for 20 minutes and the net has a 100 foot footrope with one-quarter inch mesh in the cod end. Detailed tow-by-tow data were provided by the NJDEP. To evaluate the relative abundance of winter flounder relative to the updated OHA2 southern boundary of winter flounder EFH, the following data were used:

- Egg EFH: New Jersey Ocean Trawl Survey: catch (in numbers per tow) of adults (27 cm or larger) for years 1988-2015, using any tow made between January 1 and April 30 (spawning season).
- Juvenile EFH: New Jersey Ocean Trawl Survey: catch (in numbers per tow) of juveniles (< 27 cm) for years 1988-2015, tows made during all months of the year
- Adult EFH: New Jersey Ocean Trawl Survey: catch (in numbers per tow) of adults (27 cm or larger) for years 1988-2015, tows made during all months of the year

Data were processed as follows:

1. Filter data by month and juvenile vs. adult as appropriate.
2. Combine all number at length data for a unique tow event, and sum across all lengths to obtain total number of fish per tow.
3. Transform total number of fish caught per tow using $\ln(X+1)$.
4. Plot tow data for each survey in Geographic Information System (GIS) using the beginning latitude and longitude coordinates (end coordinates are also available in the data). Tow data sets generally include information about year, month, and date of the tow as well as bottom depth, temperature, salinity, and dissolved oxygen.
5. Join catch data for each survey to the tow data for that survey, and generate GIS shapefiles for each survey that combine catch information and tow information.
6. Bin data by ten minute squares (TMS) of latitude/longitude to generate a data set with mean transformed catch per TMS.
7. Filter out TMS or fixed stations with three or fewer samples.
8. Back transform average values per TMS for TMS with adequate sampling (>3 tows).
9. Rank the back transformed values from highest to lowest catch per TMS to determine where winter flounder are at highest and lowest relative abundance, sum these average values over all TMS, and calculate the cumulative percentages by TMS.
10. Using the information about high and low catch TMS, TMS-based EFH layers were developed to show which TMS accounted for the 75th and 90th percentiles of the frequency distribution of back-transformed average catches.

Six primary map products were generated. Each map shows TMS that would be designated or not designated based on that survey and catch threshold, the average number of fish caught in each TMS (back-transformed values), and the proposed southern boundary.

- Egg EFH: January through April adult distribution and abundance
 - 75% (Map 6)
 - 90% (Map 8)
- Juvenile EFH: Year-round juvenile distribution and abundance
 - 75% (Map 9)
 - 90% (Map 10)
- Adult EFH – Year-round adult distribution and abundance
 - 75% (Map 11)
 - 90% (Map 12)

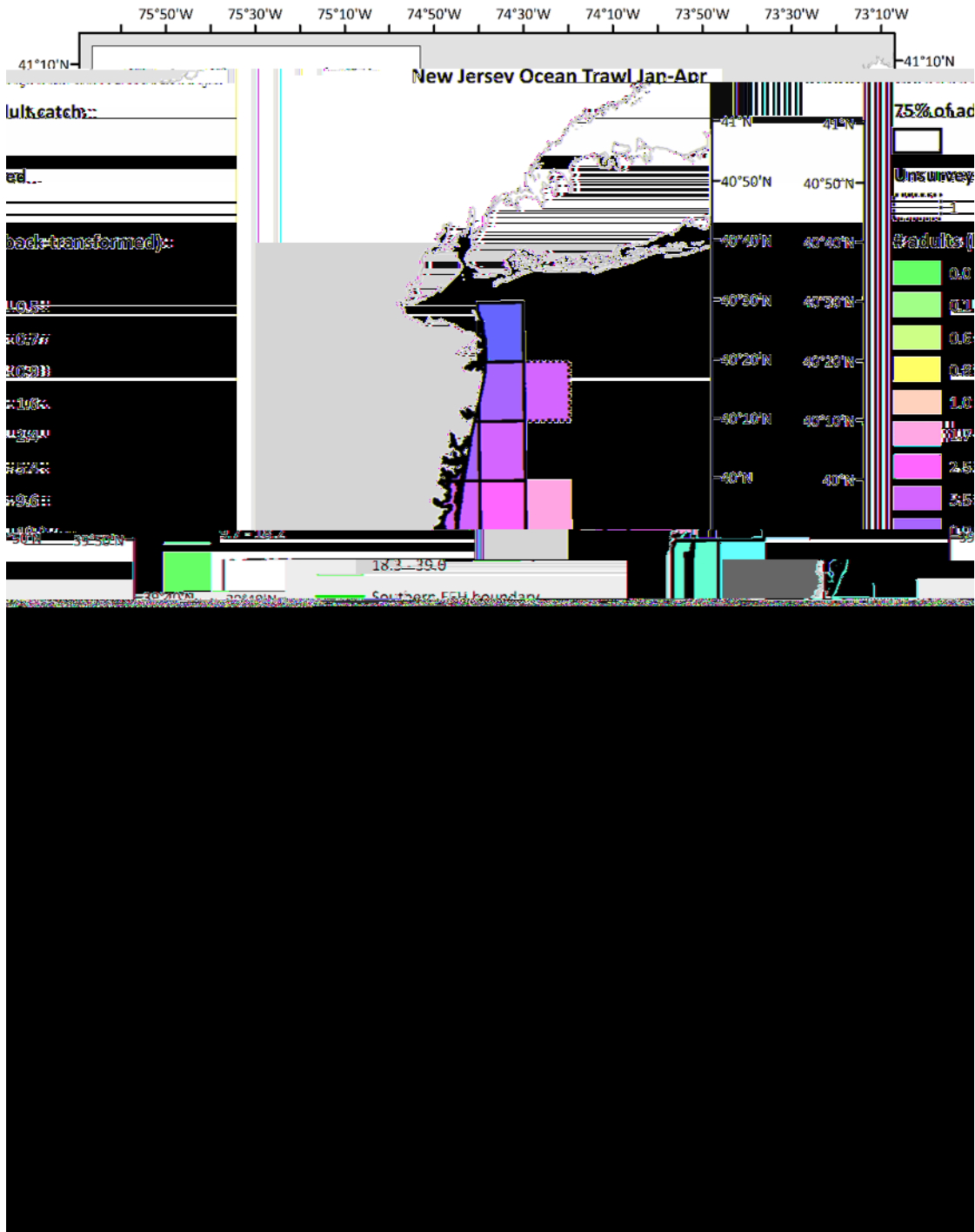
All three sets of maps show a clear north-south gradient in the abundance of adult winter flounder. Note that many of the EFH maps in the amendment in general use a 90% catch threshold, including the maps for juvenile and adult winter flounder.

Egg EFH: The TMS that encompass 75% of the distribution adults between January and April have a southern boundary of 39° 40' N, approximately Barnegat Light (Map 6). While there are some higher catch TMS further south along the NJ coastline (shown in light green shading on the map), most of the higher areas occur in northern NJ waters. All TMS identified at the 75% threshold as potential EFH are north of the proposed boundary line which is at 39° 22'. Most of the TMS identified as potential EFH using 90% threshold (Map 8) are north of the proposed boundary line. The one exception that falls within the depth limit for the egg designation (5 meters) is the TMS off the very southern tip of NJ, near Cape May. Overall, the proposed southern boundary at 39° 22' N is consistent with the 75th and 90th percentile distributions of adult fish caught between January and April in the NJ Ocean Trawl Survey. To the extent that the distribution of these adults can be used to infer the distribution of egg EFH, the most important spawning and egg habitats are likely north of the proposed boundary.

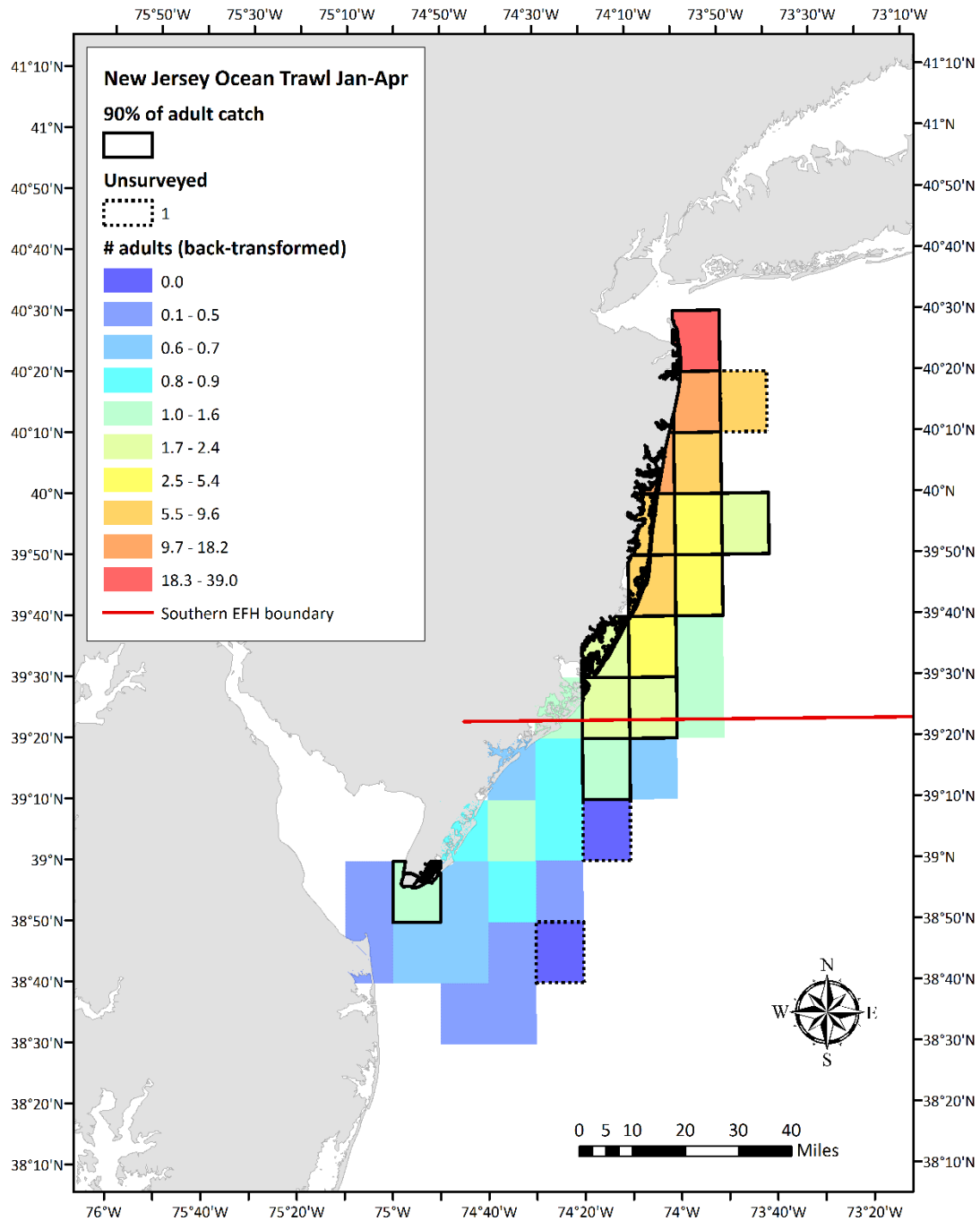
Juvenile EFH: Map 9 and Map 10 show 75% and 90% of the distribution of juveniles, year-round, along the NJ coast. The proposed boundary corresponds almost exactly with the southern limit of the 75th percentile TMS. If the southern boundary was based on the 90% threshold, additional areas of the coast would be designated, but TMS further offshore of southern New Jersey, as well as TMS in Delaware Bay, would not be.

Adult EFH: Map 11 and Map 12 show 75% and 90% of the distribution of adults, year-round, along the NJ coast. These maps are very similar to those generated based on January-April only, and indicate that adults are more abundant along the northern New Jersey coast, as compared to areas further south. The proposed boundary encompasses nearly all TMS that meet the 90% criteria.

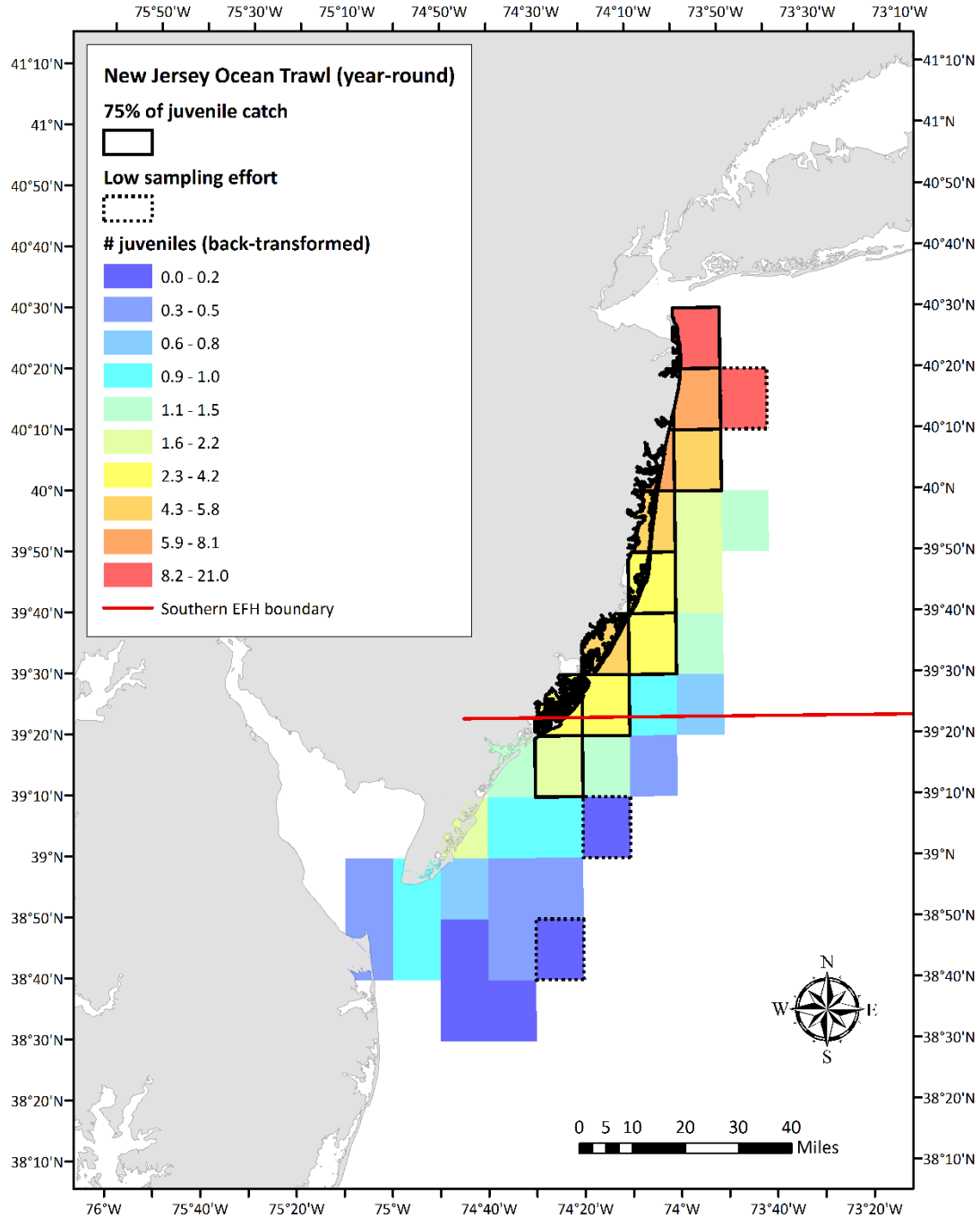
Map 7 – New Jersey Ocean Trawl Survey. Black outlined cells show locations that would be designated as egg EFH using the 75% cumulative distribution method, based on catches of adult winter flounder from January through April. Note that much of the area would be clipped as it exceeds the maximum 5 meter depth. Red line shows the southern boundary preferred by the Council at 39° 22' N.



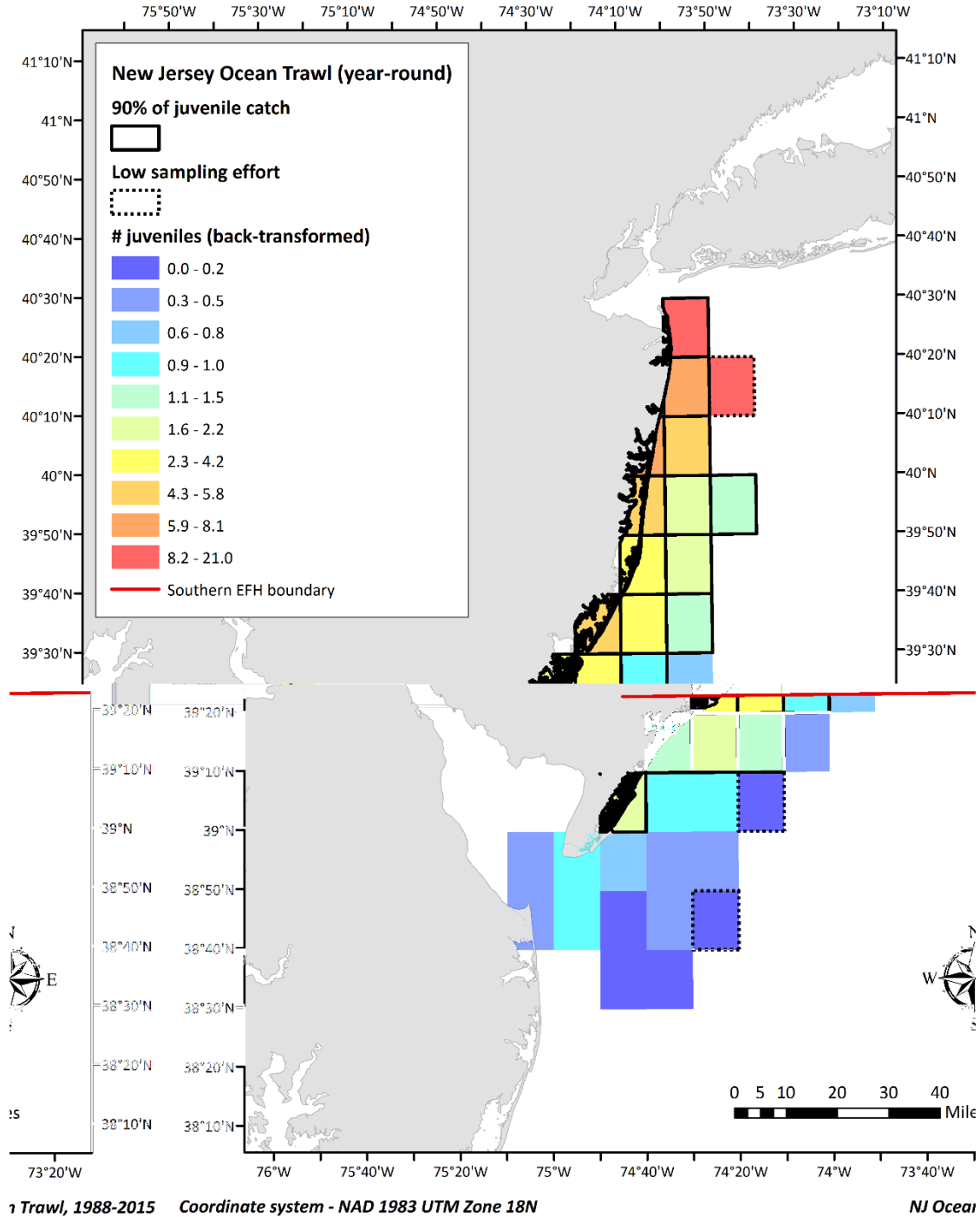
Map 8 – New Jersey Ocean Trawl Survey. Black outlined cells show locations that would be designated as egg EFH using the 90% cumulative distribution method, based on catches of adult winter flounder from January through April. Note that much of the area would be clipped as it exceeds the maximum 5 meter depth. Red line shows the southern boundary preferred by the Council at 39° 22' N



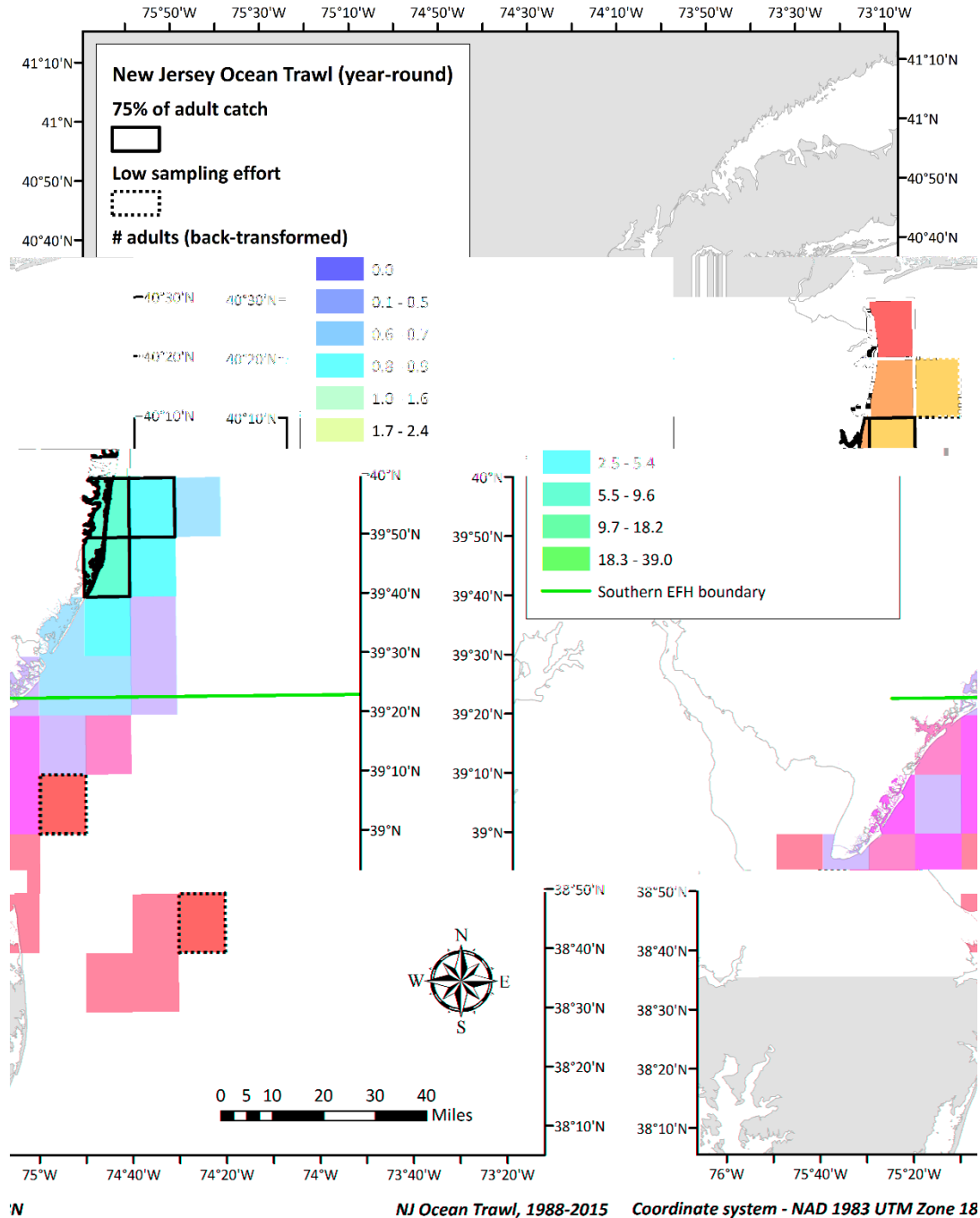
Map 9 – New Jersey Ocean Trawl Survey. Black outlined cells show locations that would be designated as juvenile EFH using the 75% cumulative distribution method, based on catches of juvenile winter flounder year-round. Red line shows the southern boundary preferred by the Council at 39° 22' N



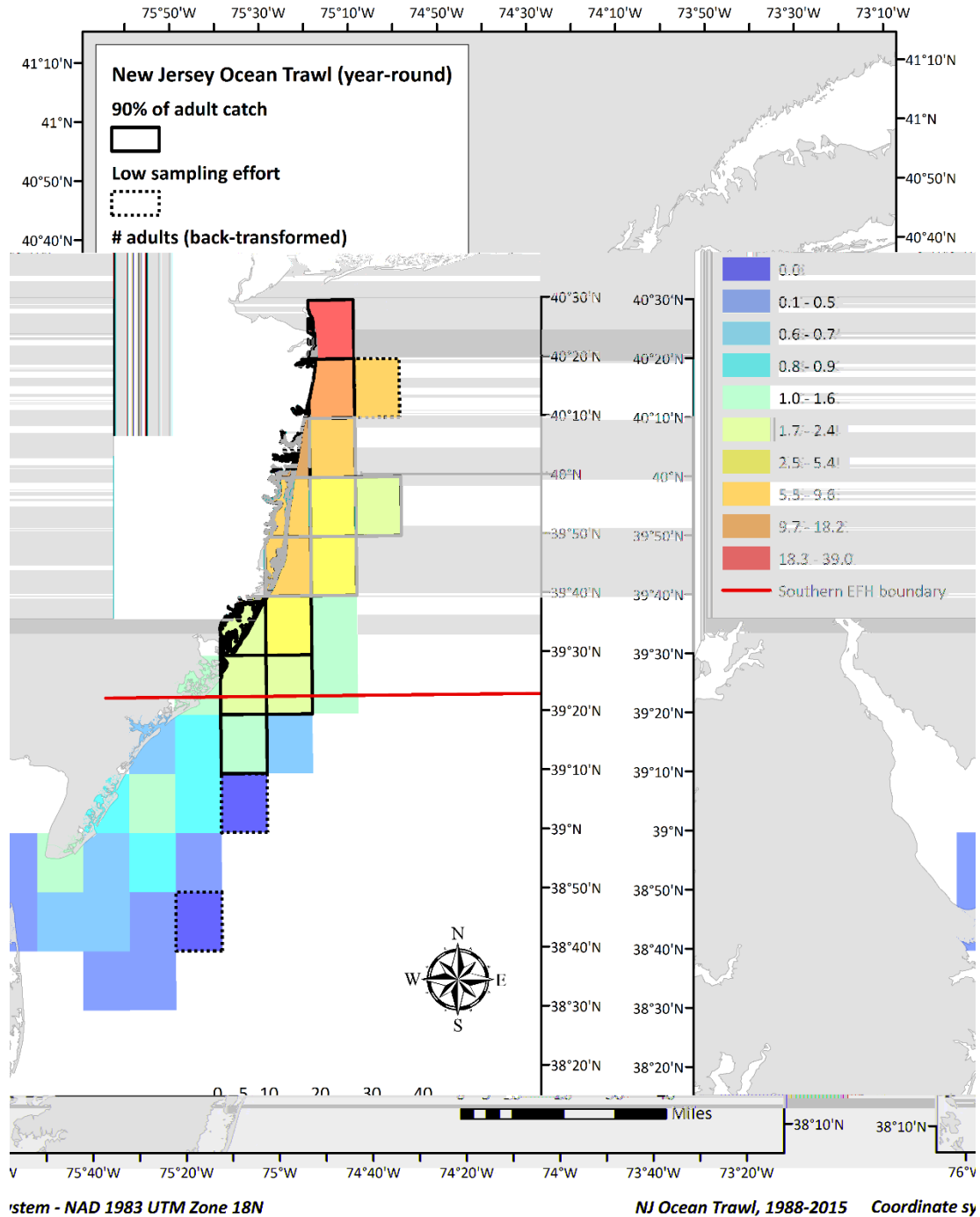
Map 10 – New Jersey Ocean Trawl Survey. Black outlined cells show locations that would be designated as juvenile EFH using the 90% cumulative distribution method, based on catches of juvenile winter flounder year-round. Red line shows the southern boundary preferred by the Council at 39° 22' N



Map 11 – New Jersey Ocean Trawl Survey. Black outlined cells show locations that would be designated as adult EFH using the 75% cumulative distribution method, based on catches of juvenile winter flounder year-round. Red line shows the southern boundary preferred by the Council at 39° 22' N



Map 12 – New Jersey Ocean Trawl Survey. Black outlined cells show locations that would be designated as adult EFH using the 90% cumulative distribution method, based on catches of juvenile winter flounder year-round. Red line shows the southern boundary preferred by the Council at 39° 22' N



Winter flounder catches in Delaware Bay

Delaware survey

Delaware's Division of Fish and Wildlife conducts two trawl surveys in Delaware Bay. The 17-foot bottom trawl survey began in 1980. This survey takes place monthly April through October at fixed stations along the western side of Delaware Bay, and monitors the relative abundance and distribution of juvenile finfish and crab species (Michels 2015). A 30-foot bottom trawl survey is used to monitor sub-adult and adult finfish at deeper stations in the middle of the bay during March through December (Michels 2015), but the 16-foot trawl survey is the focus here. Catches of winter flounder in this survey have generally been low. From 1980 to 2014, a total of 414 winter flounder were captured on 8,440 tows (only those tows with location information were used in this analysis). The time series mean catch was 0.05 fish per tow.

Stations 80, 81, and 91-96, which have had no winter flounder catch in the history of the survey (Table 3) are at the head of the bay between Wilmington and the Chesapeake and Delaware Canal (Map 13). Higher catches have tended to occur further south, with the highest average values in the middle latitudes of the bay between Woodson Beach and Pickering Beach (stations 13-32, and 99). All but two of the stations with average catches above the time series mean are located in the mid-bay latitudes. There are somewhat lower catches approaching the mouth of the bay. Catch has fluctuated over time (Figure 1), and has been below the time series mean since 2007, with no catches observed during 2008, 2010-2013. There was a high catch outlier year during 2003, when relatively larger catches per tow were observed during June and July. Across the entire time series, catches were highest during these two months, with lower average catch per tow during April/May and August/September/October (Figure 2). Station locations and average catch per tow are shown on Map 13.

The vast majority of the fish caught in this survey are smaller juveniles, with 91% of 408 fish lengths falling between 3 and 8 cm. Larger animals are rarely caught (only four adult fish 27 cm or larger).

Table 3 – Winter flounder catch (numbers of fish) in the 16-foot trawl survey in the western side of Delaware Bay, 1980 to 2014.

Station	Total catch	Average catch	Max catch	Number of tows
10	11	0.05	7	235
11	11	0.05	3	235
13	16	0.07	9	236
14	28	0.12	8	233
16	35	0.15	17	236
17	22	0.09	8	236
20	44	0.19	12	236
21	21	0.09	15	236
22	12	0.08	3	152
25	22	0.09	13	235
26	15	0.06	9	236
32	34	0.15	21	234
33	6	0.03	2	234
40	11	0.05	2	235
41	7	0.03	2	235
48	5	0.02	4	235
49	2	0.01	1	235
55	15	0.06	5	236
56	1	0.00	1	236
61	1	0.00	1	235
62	7	0.03	3	235
63	2	0.01	1	235
64	11	0.05	8	234
7	13	0.06	5	235
8	7	0.03	5	236
80	0	0.00	0	209
81	0	0.00	0	217
83	1	0.00	1	221
85	1	0.00	1	220
86	3	0.01	2	218
87	2	0.01	1	221
88	10	0.05	8	220
90	6	0.03	2	235
91	0	0.00	0	110
92	0	0.00	0	107
93	0	0.00	0	109
94	0	0.00	0	110
95	0	0.00	0	102
96	0	0.00	0	110
99	32	0.14	12	235

Figure 1 – Average winter flounder catch in the 16-foot trawl survey in the western side of Delaware Bay, by year, 1980 to 2014. 2003 is an outlier with relatively high catches during multiple tows made during June and July.

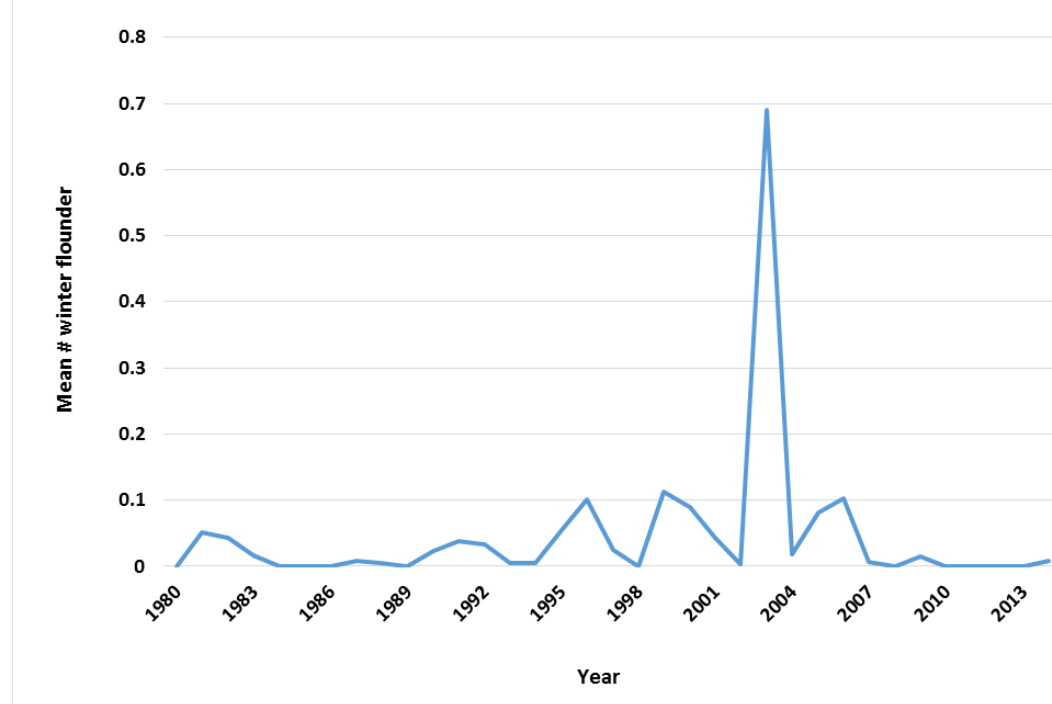
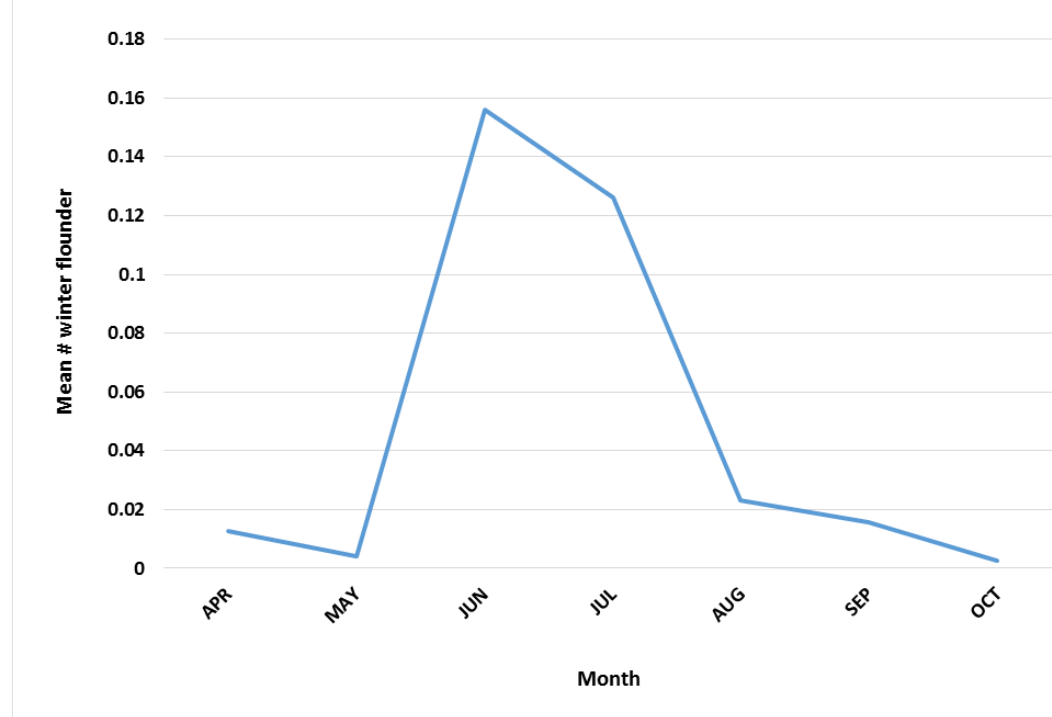
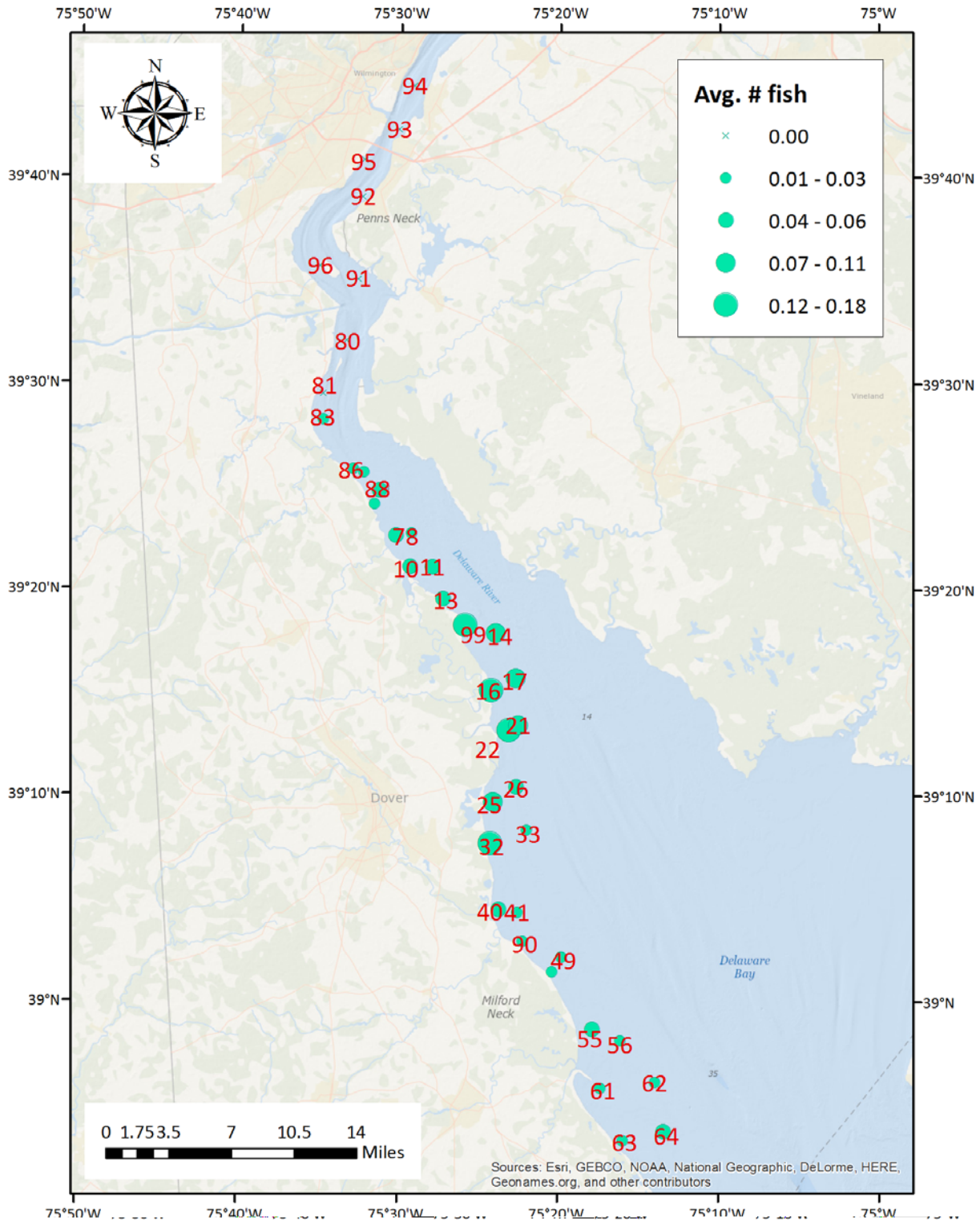


Figure 2 – Average winter flounder catch in the 16-foot trawl survey in the western side of Delaware Bay, by month, 1980 to 2014. The pattern of higher catches during June and July remains consistent even if the outlier year, 2003, is removed, but it is included here.



Map 13 – Delaware Bay 16 foot trawl survey (Delaware), 1980-2014. Stations (red labels) and average number of winter flounder caught at each station (green circles).



New Jersey survey

New Jersey’s Bureau of Marine Fisheries also conducts a juvenile finfish trawl survey using a 16-foot trawl, which began in 1991. The survey mirrors the Delaware’s Division of Fish and Wildlife trawl survey by monitoring the resources along the eastern side of the Bay. The area is surveyed each year from April through October, but the sampling months vary. Survey tows are ten minutes long at an average depth ranging from 0.6 meters to 2.4 meters. The survey also collects information on environmental parameters, including temperature, salinity, and dissolved oxygen levels. From 1991 to 2012, 410 winter flounder were encountered in the survey tows (Table 4).

The average catch per tow over the time series was 0.23 fish, with only 13% of tows catching winter flounder. Catches have fluctuated over time, but have been low recently (Figure 3). Catch rates are highest during June (Figure 4), with no catches in April or November and very low non-zero catches in May, August, September, and October. Station locations and average catch per tow at each station are shown in Map 14.

Table 4 –Juvenile (< 27 cm) winter flounder catch by station and year between 1991 and 2012, April-November in the Delaware Bay Trawl Survey conducted by New Jersey (east side of bay). Stations and years with zero catch are not shown.

Year	Stations with juvenile winter flounder during at least one year											Total
	12.0	15.0	19.0	23.1	29.1	30.0	31.0	39.0	47.1	54.0	60.0	
1991								1				1
1993						1				2		3
1995		1						1				2
1996				1				1		1		3
1998				15		1		5		1		22
1999		4		2	1	7	10	6	3	11		44
2000	1		1	3	1		2	36	2	2		48
2001				4		2		5		1	7	19
2003			2	5	3	2		1			2	15
2005	5		9	4	4		36	4	45	142	2	251
2007											1	1
2008				1								1
Total	6	5	12	35	9	13	48	60	50	160	12	410

Figure 3 – Average catch per tow in the NJ Delaware Bay survey, by year, 1991-2012.

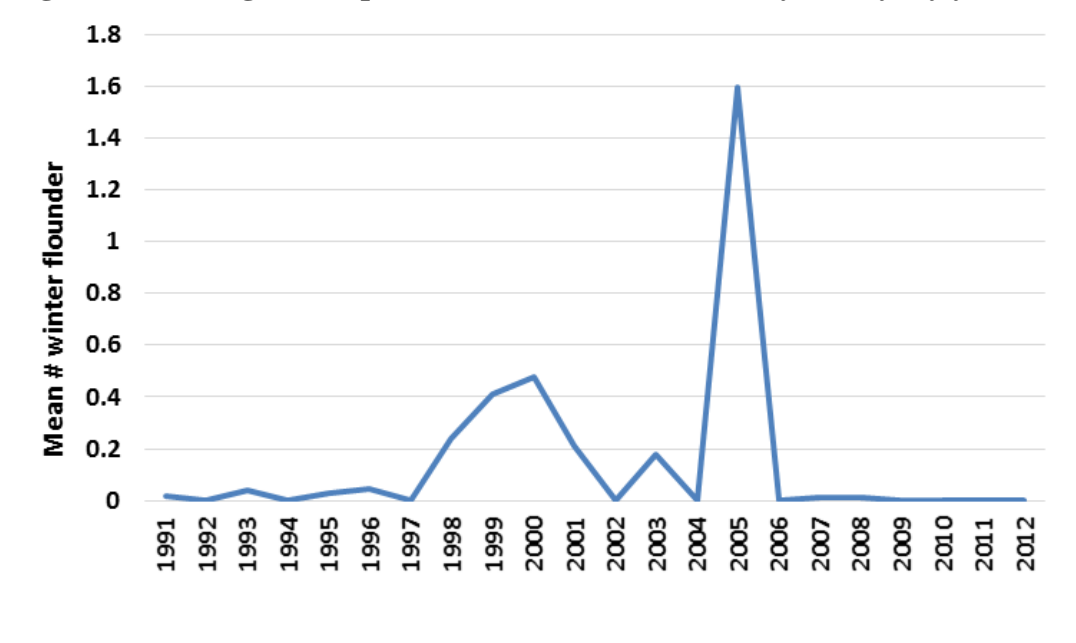
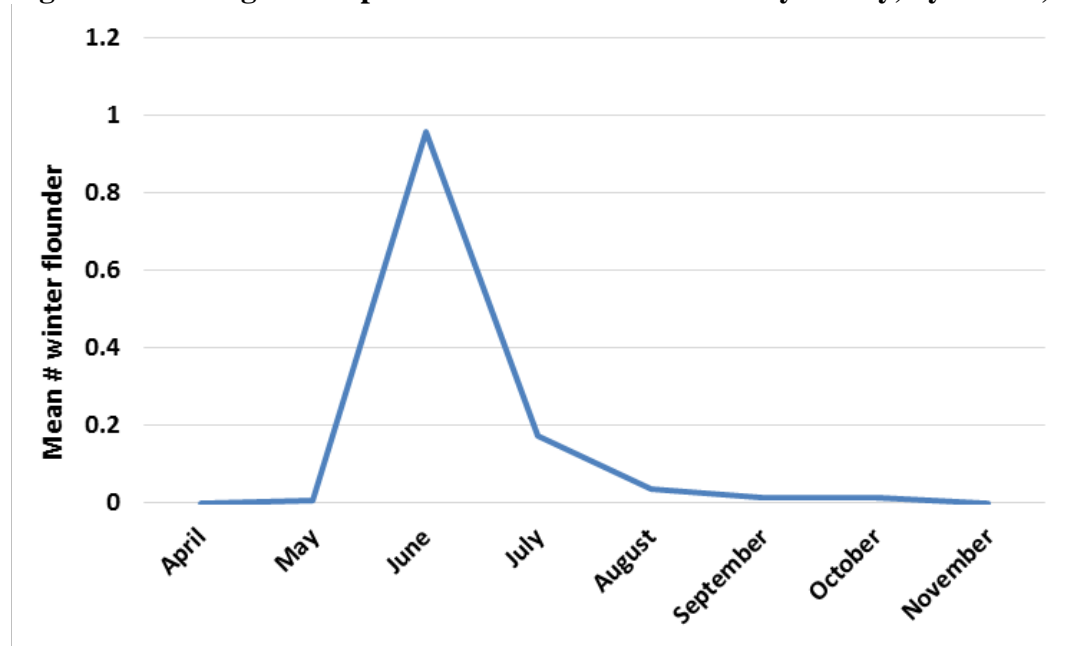
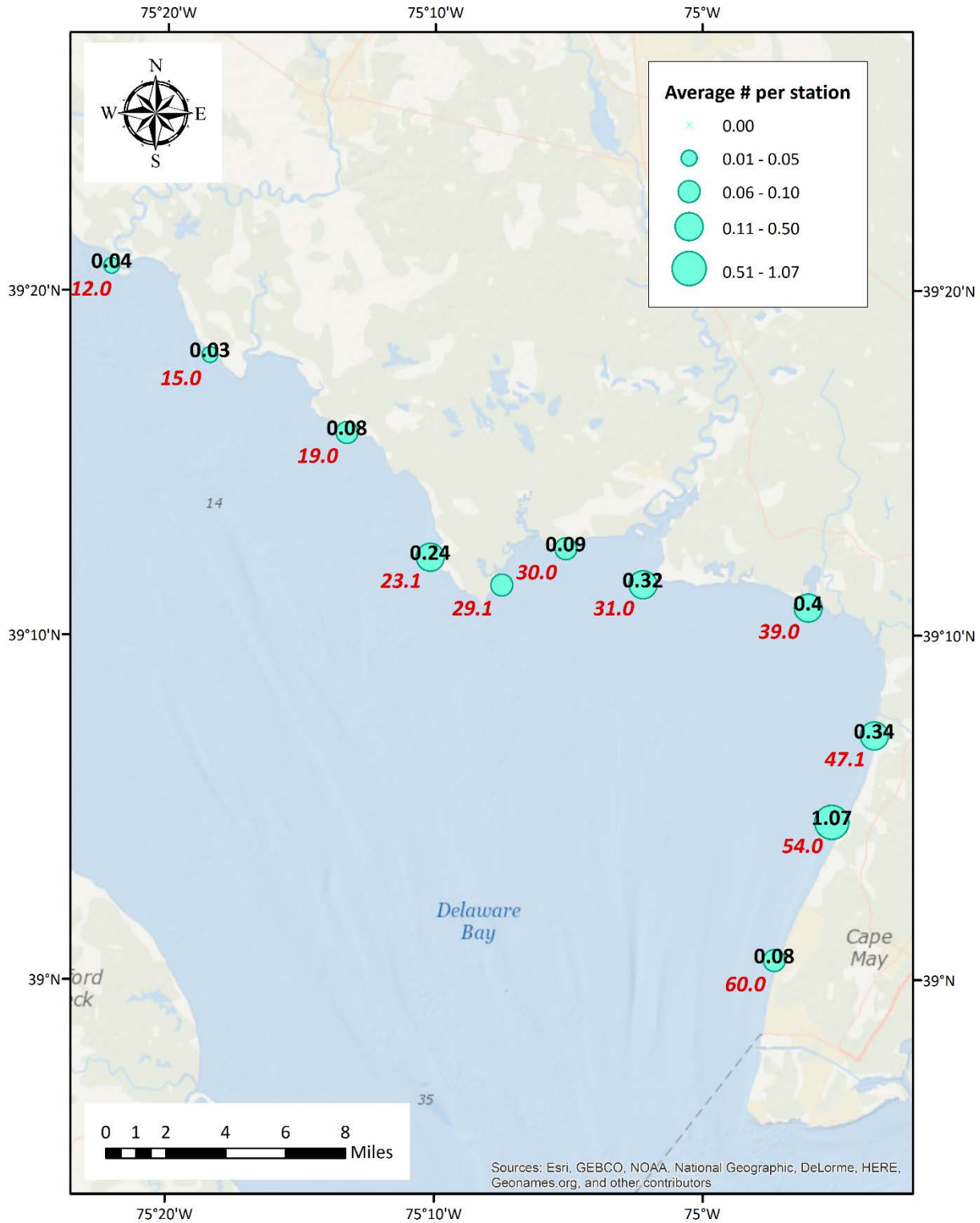


Figure 4 – Average catch per tow in the NJ Delaware Bay survey, by month, 1991-2012.



Map 14 - Delaware Bay 16 foot trawl survey (New Jersey), 1991-2012. Station locations (red labels) and average catch per station (green circles and black labels). Average catch at station 29.1 was 0.06 fish.



References

- Able, K. W. and M. Fahay (2010). Ecology of Estuarine Fishes. Baltimore MD, Johns Hopkins Univ. Press: 566pp.
- Berry, W. J., Rubinstein N.I., Hinchey E.K., Klein-MacPhee, G., and Clarke, D.G. (2011). Assessment of Dredging-Induced Sedimentation Effects on Winter Flounder (*Pseudopleuronectes americanus*) Hatching Success: Results of Laboratory Investigations. Proceedings of the Western Dredging Association Technical Conference and Texas A&M Dredging Seminar. Nashville, TN.
- Chant, R. J., M. C. Curran, et al. (2000). Delivery of Winter Flounder (*Pseudopleuronectes americanus*) Larvae to Settlement Habitats in Coves Near Tidal Inlets. Estuarine, Coastal and Shelf Science 51(5): 529-541.
- Crawford, R. (1990). Winter flounder in Rhode Island coastal ponds. R.I. Sea Grant.
- Curran, M. C. and K. W. Able (2002). Annual Stability in the Use of Coves near Inlets as Settlement Areas for Winter Flounder (*Pseudopleuronectes americanus*). Estuaries 25(2): 227-234.
- Goldberg, R., B. Phelan, et al. (2002). Variability in Habitat Use by Young-of-the-Year Winter Flounder, *Pseudopleuronectes americanus*, in Three Northeastern U. S. Estuaries. Estuaries 25(2): 215-226.
- Howell, P.T., D.R. Molnar, and R.B. Harris. (1999) Juvenile winter flounder distribution by habitat type. Estuaries 22(4): 1090-1095.
- Manderson, J. P., J. Pessutti, et al. (2004). Shallow water predation risk for a juvenile flatfish (winter flounder; *Pseudopleuronectes americanus*, Walbaum) in a northwest Atlantic estuary. Journal of Experimental Marine Biology and Ecology 304(2): 137-157.
- Manderson, J. P., J. Pessutti, et al. (2003). Winter flounder settlement dynamics and the modification of settlement patterns by post-settlement processes in a NW Atlantic estuary. Mar. Ecol. Prog. Ser. 253: 253-267.
- Manderson, J. P., B. A. Phelan, et al. (2002). Spatial dynamics of habitat suitability for the growth of newly settled winter flounder *Pseudopleuronectes americanus* in an estuarine nursery. Mar. Ecol. Prog. Ser. 228: 227-239.
- Michels, S. Delaware's Trawl Survey Program, Delaware Division of Fish and Wildlife. Retrieved August 3, 2015, from <http://www.dnrec.delaware.gov/fw/SiteCollectionDocuments/FW%20Gallery/Research/rawl%20doc.pdf>
- Mulvey, C., T. Costanzo, et al. (2010). Winter Flounder Habitat Utilization and Environmental Windows in New York and New Jersey Harbor. 12th Triannual International Conference on Ports. T. Ward and B. I. Ostbo. Jacksonville, FL: 530-539.
- Neilan, B. (2015). Studying the Delaware Bay - 2014 Report. Retrieved August 3, 2015, from <http://www.state.nj.us/dep/fgw/artdelbaystudy14.htm>.
- Nye, J. A., J. S. Link, et al. (2009). Changing spatial distribution of fish stocks in relation to climate and population size on the Northeast United States continental shelf. Mar. Ecol. Prog. Ser. 393: 111-129.
- Pereira, J. J., R. Goldberg, et al. (1999). Essential Fish Habitat Source Document: Winter Flounder, *Pseudopleuronectes americanus*, Life History and Habitat Characteristics. 48pp.
- Phelan, B. A. (1992). Winter flounder movements in the inner New York Bight. Trans. Amer. Fish. Soc. 121(6): 777-784.
- Phelan, B. A., R. Goldberg, et al. (2000). Estuarine and habitat-related differences in growth rates of young-of-the-year winter flounder (*Pseudopleuronectes americanus*) and tautog (*Tautoga onitis*) in three northeastern US estuaries. Journal of Experimental Marine Biology and Ecology 247(1): 1-28.
- Scarlett, P. G. (1991). Relative abundance of winter flounder (*Pseudopleuronectes americanus*) in nine inshore areas of New Jersey. Bull. N.J. Acad. Sci. 36(2): 1-5.

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- (1991). Temporal and spatial distribution of winter flounder, *Pseudopleuronectes americanus*, spawning in Navesink and Shewsbury Rivers, New Jersey. N.J. Dept. Environ. Prot., Div. Fish Game and Wildl., Bur. of Mar. Fish., Trenton, NJ. 12pp.
- Scarlett, P. G. and R. L. Allen (1989). Results of fall and winter ichthyoplankton sampling in the Manasquan River, 1984-1986. . N.J. Dept. Environ. Prot., Div. Fish Game and Wildl., Bur. of Mar. Fish., Trenton, NJ. 37pp.
- Scarlett, P., and R. Allen. 1992. Temporal and spatial distributions of winter flounder (*Pseudopleuronectes americanus*) spawning in Manasquan River, New Jersey. Bulletin of the New Jersey Academy of Sciences 37: 13-17.
- Schultz, E., Pereira, J.J., and Auster, P.J. 2007. Determining winter flounder spawning sites in two Connecticut estuaries. Final report submitted to the Connecticut Department of Environmental Protection. 29pp plus tables and figures.
- Shaheen, P. A., L. L. Stehlik, et al. (2001). Feeding behavior of newly settled winter flounder (*Pseudopleuronectes americanus*) on calanoid copepods. Journal of Experimental Marine Biology and Ecology 257(1): 37-51.
- Sogard, S. M., K. W. Able, et al. (2001). Long-term assessment of settlement and growth of juvenile winter flounder (*Pseudopleuronectes americanus*) in New Jersey estuaries. Journal of Sea Research 45(3-4): 189-204.
- Stone, S. L., T. A. Lowery, et al. (1994). Distribution and abundance of fishes and invertebrates in Mid-Atlantic estuaries. NOAA/NOS Strategic Environmental Assessments Division, Silver Spring, MD. 280pp.
- Stoner, A. W., J. P. Manderson, et al. (2001). Spatially explicit analysis of estuarine habitat for juvenile winter flounder: Combining generalized additive models and geographic information systems. Mar. Ecol. Prog. Ser. 213: 253-271.
- Wilber, D. H., D. G. Clarke, et al. (2013). Identification of winter flounder (*Pseudopleuronectes americanus*) estuarine spawning habitat and factors influencing egg and larval distributions. Estuaries and Coasts 36: 1304-1318.
- Wuenschel, M. J., K. W. Able, et al. (2009). Seasonal patterns of winter flounder *Pseudopleuronectes americanus* abundance and reproductive condition on the New York Bight continental shelf. Journal of fish biology 74(7): 1508-1524.