NEW YORK AND NEW JERSEY HARBOR DEEPENING PROJECT

APPLICATION of WINTER FLOUNDER EARLY LIFE HISTORY DATA to SEASONAL DREDGING CONSTRAINTS and ESSENTIAL FISH HABITAT DESIGNATIONS

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Table of Contents

List of Tables

List of Figures

Introduction

Determinations of seasonal dredging restrictions throughout the United States are frequently based on outdated information or perceptions of the dredging process and in only a few instances on conclusive scientific evidence (National Research Council 2001). Within New York and New Jersey Harbor (the Harbor), an opportunity exists to use results of an extensive aquatic biological sampling program as a technical basis for informed dredging management practices and to enhance protection of early life history stages of winter flounder, *Pseudopleuronectes americanus*.

Currently, the United States Army Corps of Engineers – New York District's (USACE-NYD) congressionally authorized Harbor Deepening Project (HDP) is under construction. The HDP is a multi-year Federal channel deepening program aimed at improving Harbor navigation and safety while minimizing impacts to the overall environment, as well as promoting environmental sustainability and improvements. Prior to construction, a comprehensive review of the literature related to the biological resources in the Harbor indicated that there were insufficient data available to evaluate the relative importance of aquatic habitats, including the use of the Harbor's navigation channels by resident and migrant finfish species, shellfish and benthic macro-invertebrate species (USACE-NYD 1998). A systematic sampling program, the Aquatic Biological Survey (ABS), was developed in coordination with the National Marine Fisheries Service (NMFS) and appropriate state environmental regulatory agencies in New York and New Jersey, as well as the project sponsor, the Port Authority of New York and New Jersey (PANYNJ) to assess the temporal and spatial distribution and abundance patterns of these biotic resources.

Since its inception in 1998, the ABS has undergone a number of modifications and enhancements, such as the addition of new sampling locations in the Lower Bay (Figure 1), in order to provide the necessary and relevant data for essential fish habitat (EFH)[1] coordination

[1] EFH is defined under section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCA) as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267) as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity."

with NMFS and state regulatory agencies as data needs and agency interests/concerns arose. The later years of the ABS program focused on winter flounder distribution and seasonal patterns of habitat use. Winter flounder was selected as the primary target species because it has experienced a dramatic decline in abundance over a span of decades, is commercially and recreationally important in the Northeast, and is representative of other federally managed species.

Developing an understanding of when and where winter flounder eggs and larvae are present within the HDP area and how their presence is related to environmental factors greatly improves the ability to effectively manage dredging activities in the Harbor. The extensive database collected prior to and during the construction of the HDP has provided an opportunity for decision makers to apply management practices based on sound science that allow for both the protection of EFH species and the efficient and effective execution of navigational improvements. USACE-NYD has used this database to address the following local and regional EFH issues:

1. The application of the 2001 conservation recommendations (NMFS 2001) issued by the National Marine Fisheries Service (Northeast Region) to the seasonal dredging restrictions as they pertain to existing and future construction contracts for the Harbor Deepening Project (HDP).

2. The proposed, but not adopted, re-designation[2] of winter flounder egg and larvae EFH from 5 and 6 meters (16 and 20 feet), respectively, to 20 meters (66 feet).

This report provides a complete analysis of the 2002 – 2011 ABS epibenthic sled sampling program and updates the 2010 report (USACE 2010) with data from the final year of sampling. These reports focus on winter flounder early life stage (eggs and larvae) data as they pertain to winter flounder EFH utilization within the Harbor. A related examination of winter flounder egg

[2]During preparation of a programmatic Environmental Impact Statement (EIS) and Omnibus EFH Amendment, the New England Fishery Management Council flounder early life history stages and voted, in March 2010, not to change the designation based on an evaluation of NYD ABS data during the early stages of their PEIS process.

and larval distributions in the Harbor is provided in Wilber et al. (2013). Information regarding data analysis and methods for the ABS can be found in Appendix A. Summaries of additional water quality, sediment and hydrodynamic data collected from other HDP monitoring programs conducted by USACE-NYD can be found in Appendix B. Appendix C evaluates the impacts that the seasonal dredging restrictions have had on the overall construction of the HDP.

Application to the 2001 Conservation Recommendation – Seasonal Dredging Constraints

In 2001, the National Marine Fisheries Service (NMFS) - Northeast Region - issued a conservation recommendation (CR) letter (NMFS 2001) regarding potential impacts of the HDP on federally managed EFH species. The potential project impacts identified in the letter included the re-deposition of sediment suspended during dredging, physical removal of bottom habitat, entrainment of eggs and larvae in dredging equipment, and loss of EFH function. To mitigate these potential project impacts, NMFS recommended seasonal dredging constraints for some navigation channels based on location, sediment characteristics, and the temporal use of the project area by early life stage (eggs and larvae) winter flounder. Specifically, the 2001 CR letter identified winter flounder as a species "that will be most affected by the deepening, or are representative of other federally managed species." The USACE-NYD initiated the multi-year ABS sampling program to inform decision makers about the distribution and abundance of demersal biological resources, such as winter flounder, in the Harbor. The NMFS agreed to a seasonal dredging restriction from February 1 through May 31, which due to data unavailability at the time, was a "very conservative, risk-adverse approach." However, NMFS encouraged USACE-NYD to "revisit the consultation process during the pre and actual construction phases of the project if the information affects the basis for NMFS conservation recommendations (50 CFR 600.920(k))", including if "altered or new information become available regarding ESA or EFH issues."

Based on the extensive ABS dataset and other monitoring programs associated with the HDP, USACE-NYD has revisited the local consultation process regarding seasonal dredging restrictions as they pertain to existing and future construction contracts for the HDP. Based on the latest scientific data from these studies and the current HDP construction plans, the project related impacts identified in the 2001 CR letter may have limited application as they pertain to winter flounder EFH within the Harbor. The following sections discuss each of the potential modes of ecological impact identified in the 2001 CR related to dredging activities, which include re-deposition of suspended sediment, entrainment of early life stages, physical removal of bottom habitat and loss of EFH function. Relevant data sources are used to describe the spatial and temporal distribution of early life stage winter flounder based upon empirical field data collected during conduct of the ABS.

Re-deposition of Suspended Sediment

The 2001 CR letter identified the re-deposition of sediment suspended during dredging as a potential source of impact on EFH. For the past five years, USACE-NYD has conducted a Water Quality/Total Suspended Solids (TSS) monitoring program to measure the spatial extent and temporal dynamics of suspended sediment plumes associated with the mechanical dredging of fine-grained sediments. Plume surveys were conducted during dredging operations using an "environmental bucket" in the Arthur Kill and Newark Bay. The results of the TSS surveys in these waterways have demonstrated that, similar to the conclusions of Bohlen *et al.* (1996), resuspended sediment plumes were largely confined to the bottom of the navigation channel with no evidence of plume excursion beyond the channel side slopes (USACE-NYD 2007 and USACE-NYD 2008). Therefore, potential project related impacts to nearby shallow water habitats in those waterways as a consequence of dredging with an environmental bucket would likely be minimal given that channel depths, prevailing water current circulation patterns, and applied best management practices would effectively keep suspended sediment plumes within the boundaries of the navigation channels.

Entrainment of Early Life Stages

The 2001 CR letter identified hydraulic entrainment by dredging equipment as a primary concern for "species with limited mobility including eggs and larvae of winter flounder, early life stages of lobsters and overwintering winter flounder, striped bass and blue crabs." Potential adverse impacts from hydraulic entrainment are primarily associated with the use of hopper dredges which, although relevant to a few Ambrose Channel contracts, has not been a common method of dredging during the construction of the HDP.

Physical Removal of Bottom Habitat

The 2001 CR letter identified the "physical removal of bottom habitat resulting from the blasting and dredging" as a primary concern because these activities would potentially "eliminate or reduce the ecological value of habitat used by a number of species including winter flounder…" The current winter flounder EFH designation does not include Harbor channels as water depths are greater than 6 meters. Therefore, dredging/blasting in channels did not have an impact on winter flounder EFH. In areas where the channels were widened and there was an impact to the flats, the USACE-NYD mitigated these impacts. In addition, USACE-NYD conducted winter flounder habitat enhancement and restoration in Port Jersey.

Loss of EFH Function

Defined parameters for EFH function were not provided in the 2001 CR letter. However, functional EFH is described on the NMFS website to "include aquatic areas and their associated physical, chemical, and biological properties that are used by fish" as well as substrate that "includes sediment, hard bottom, structures underlying the waters, and associated biological communities."

The ABS program provides broad spatial and temporal data on the occurrence of early life stage winter flounder within the Harbor. The spatial data show the relative utilization of both channel and non-channel areas in each of the harbor regions by winter flounder and the potential relationship of the results to EFH function. The temporal data were analyzed as a basis for re-evaluation and refinement of the conservation recommendation with respect to the timing of winter flounder egg and larvae occurrences in the Harbor; to establish a relationship between winter flounder life stage data and EFH function; and to present cumulative probability graphs that address concerns about inter-annual variability in the data.

Spatial Occurrence of Winter Flounder Early Life Stages

In order to assess distinct and or discrete areas or habitats within or adjacent to HDP Federal channels, USACE- NYD analyzed ten years (2002-2011) of ABS winter flounder early life stage data. These data were used to determine the presence and location of winter flounder viable egg[3] and larval occurrences throughout the project area, including Arthur Kill/Newark Bay, Upper Bay, and Lower Bay (Figures 2 and 3). Unless otherwise specified, study results refer to viable eggs only.

Winter flounder eggs are distributed throughout the Lower and Upper Bay areas of the Harbor, with significantly lower egg densities in the Arthur Kill/Newark Bay (AK/NB) area (Figure 4a and b, Kruskal-Wallis test statistic = 8.51, $p < 0.05$). Averaged over the ten year period, egg densities in the AK/NB area accounted for less than 5% of the total egg collections within the project area (Figure 4b). Winter flounder larval densities are highest in the Lower Bay and lowest in the AK/NB area where yolk-sac and post-yolk-sac larval collections averaged 10% and 14%, respectively, of the overall larval collections from 2002 to 2011 (Figure 5).

Upper and Lower Bays

Within the Upper and Lower Bays, shallow benthic habitat (typically less than 6 meters) is used as winter flounder spawning habitat. In some years, eggs were concentrated in either the Lower (2002 and 2004) or Upper (2005 and 2006) Bay areas (Figure 4a). Yolk-sac and post-yolk-sac larval densities were highest in the Lower Bay (Figure 5). There were no statistical associations (Appendix A) between egg and larval distributions among the Harbor areas and several environmental variables (river discharge, salinity, dissolved oxygen and temperature). *Because winter flounder egg and larval distributions are most highly concentrated in the Upper and Lower Bays (Figures 4 and 5), seasonal dredging restrictions in these areas should be carefully refined to encompass demonstrated periods of egg and larval occurrences.*

[3] Viable eggs were fertilized eggs showing various stages of development at the time of preservation. Non-viable eggs include those that were unfertilized as well as those fertilized but obviously dead: an egg that has become opaque in appearance or has signs of fungus and/or other types of deterioration.

Arthur Kill/Newark Bay

Of the 4,137 viable eggs collected from 2002 to 2011, only seven were collected in the Arthur Kill and these collections were confined to two of the five stations sampled in the Arthur Kill area (Table 1). Averaged over the ten-year study period, the percent contribution of eggs to the total collections within the study area was 1% for one Arthur Kill station and zero for the other four stations (Table 1). *These data strongly indicate that the Arthur Kill area is not utilized as a primary spawning habitat by winter flounder, and therefore, dredging restrictions in February that are designed to protect winter flounder eggs are not necessary for this area*. Low larval densities in the AK/NB area (Figure 5) reduce the risk of impact from dredging on the larval stage. Although larvae are more widely distributed into the AK/NB areas than eggs, larval densities in these areas are low compared to the Lower Bay ($F = 44.8$, $p < 0.001$; Table 2).

Egg collections at Newark Bay stations totaled 58 and 85% of these eggs were collected at a single station (NB-7) located directly north of Shooter's Island (Elizabeth Flats). *With the exception of the Elizabeth flats area, other areas sampled in Newark Bay were not consistently utilized as winter flounder spawning habitat and therefore dredging-related impacts on winter flounder eggs and larvae may be considered minimal for the Newark Bay area and the current seasonal restrictions adjusted accordingly.*

Temporal Occurrence of Winter Flounder Early Life Stages (Seasonal Dredging Restrictions)

The current seasonal dredging restriction within the Harbor associated with winter flounder early life stages is typically from February 1 to May 31 as recommended in NOAA's 2001 Conservation Recommendations and as issued for the HDP by the regulating states of New York and New Jersey (Table 3). Subsequently, USACE-NYD has coordinated with and provided ABS data to resource managers, such as NOAA and the regulating states of New York and New Jersey, to assist in making informed decisions regarding seasonal dredging restrictions based on the latest available data. ABS data were used to determine if the seasonal dredging restriction could be modified to either better protect winter flounder or remove unnecessary restrictions on dredging. On a HDP contract by contract basis the ABS data have been used to justify adjustments to both the start and end dates of seasonal dredging restrictions by the states of New York and New Jersey. *Based on long-term data derived from the ABS , the current dredging restrictions for the Upper and Lower Bays in the Harbor can be reduced to the time period between mid-February and mid-May and remain a risk-averse measure*.

ABS data indicate winter flounder eggs occur in the Harbor from early February to early April, with 90% of the annual egg collections obtained after 18 February in nine of ten years (Figure 6). In addition, 90% of yolk-sac larvae were collected during April and 90% of post-yolk sac larvae were collected by 16 May of each year (Figure 6).

Further reductions to the dredging restriction during May would be defensible in some years because of the inverse relationship between water temperature and the presence of post-yolk-sac larvae in May. Study results indicate that the two years in which the 90% collection of post-yolk-sac larvae occurred later in May (2003 and 2005) were years when extremely low water temperatures were experienced in March at less than 2^{o}C (Figure 7). This finding is consistent with previous studies that have demonstrated that extremely cold temperatures delayed egg and larval development (Laurence 1975, Williams 1975, Sogard *et al.* 2001). Science-based management decisions on dredging restrictions in May should therefore be assessed by NOAA and the States in coordination with USACE-NYD by reviewing March water temperatures (data available online, NOAA station ID 8518750) to estimate whether larvae would still be present in the Harbor during mid to late May. The feasibility of this management approach, however, may be constrained in some years by the availability of dredge equipment and the lead time needed to manage the dredging contracting process.

Application to the Potential EFH Depth Re-Designation

The New England Fishery Management Council (NEFMC) in preparing a programmatic Environmental Impact Statement (EIS) and Omnibus EFH amendment,re-evaluated winter flounder egg and larvae depth EFH designations. Under the current winter flounder EFH designation (Table 4), Federal navigation channels are not considered EFH as channels depths are typically greater than 12 meters (39 feet). However, a re-designation of winter flounder EFH from the current depth of 5 and 6 meters (16 and 20 feet) for eggs and larvae, respectively, to a depth of 20 meters (66 feet) would potentially include all existing and planned navigation channels in the Harbor. Dredged navigation channels are a distinct habitat maintained in a disturbed condition presumed to be unsuitable for winter flounder spawning and nursery habitat.

USACE-NYD coordinated with the NEFMC and the NMFS on the potential re-designation with respect to the impact this action would have on all regional navigation channel maintenance and improvement projects. Coordination included sharing ABS data, attending a regional Fishery Management Council Habitat Plan Development Team (HPDT) meeting to present the latest ABS results relevant to the potential depth re-designation (Table 5), presenting ABS results to NMFS scientists at the Howard Laboratory, Sandy Hook, adding sampling stations in response to feedback at the HPDT and NMFS meetings, and conducting specific data analyses requested at these meetings. During the HPDT meeting, the ABS dataset, containing characterizations of spatial and temporal occurrences of early life stage winter flounder, was identified by the HPDT as one of the most robust data sets for winter flounder early life history stages on the East Coast. In response to the new information provided by the ABS results and the analyses that addressed particular agency concerns, the NEFMC voted not to change the existing EFH depth designation for winter flounder eggs and larvae.

The ABS data were evaluated to determine if channels are used as spawning habitat by winter flounder. Egg densities at channel stations relative to non-channel stations varied annually over the ten-year study (Figure 8). Multiple regression analysis of this inter-annual variability in the relative abundance of eggs in channels revealed no significant associations with salinity, dissolved oxygen, or river discharge. Further examination of the relationship between eggs in the channels and water temperature revealed there was a significant correlation between the duration of extremely cold temperatures (cumulative degree-days for the first 8 weeks of each calendar year) and the annual percentage of eggs in the channels (Figure 9, $r = -0.78$, $p < 0.01$). The highest incidences of winter flounder egg collections in the channels occurred in years with the lowest temperatures and most prolonged low temperatures. The presence of eggs in the channels was significantly correlated with extremely low water temperatures. *Under extreme cold water conditions, winter flounder eggs develop more slowly (Williams 1975, Keller and Klein-*

MacPhee 2000) and therefore are present in the Harbor longer and may be more susceptible to being transported from their shallow spawning sites into the deep channels, which are not high value spawning sites as determined by existing literature and ABS data.

Consistent with reports in the scientific literature (NMFS 1999, Shultz *et al.* 2007), results of the ABS surveys indicate that winter flounder seek shallow estuarine habitat for spawning. For instance, early developmental stage eggs (stages 1 and 2) were collected (presumably in proximity to spawning sites) at non-channel Lower Bay stations with significantly shallower depths (mean = 5.3 m) compared to non-channel Lower Bay stations where early stage eggs were not collected (mean = 7.9 m, F = 9.4, p = 0.01). Early-stage eggs (stages 1 and 2) were collected primarily at non-channel stations. Also, samples that contained multiple egg stages (presumably from multiple spawning events, which is indicative of spawning sites or sinks) were collected primarily at non-channel stations (Table 1). *These results, therefore, strongly indicated that the Federal channels were not used as spawning habitat by winter flounder in the Harbor and the re-designation of winter flounder early life stage EFH to 20 meters (66 feet) was not warranted.*

Management Implications

As a valuable commercial and recreational species, winter flounder has remained a species of importance to local and regional resource managers. Recent assessments of the Southern New England/Mid-Atlantic stock have identified declines in commercial landings and recreational catches since the mid 1980s (ASMFC 1998 and Vonderweidt *et al*. 2006). The seasonal dredging constraints set nearly ten years ago, in the absence of site-specific data, provided broad guidelines to protect winter flounder eggs and larvae from potential dredging-related impacts. Despite the application of very conservative seasonal restrictions to dredging programs, winter flounder stock declines continue and no clear relationship between the near shore occurrence of eggs and larvae and offshore stock recruitment have been established. By taking into consideration the robust dataset collected over the ensuing ten years, refinements can be made in the existing broad temporal and spatial parameters, as related to the presence of essential fish habitat and winter flounder. An adaptive management application of the extensive scientific dataset collected as part of the HDP, in conjunction with a better understanding of EFH function and target species habitat requirements, can serve to justify revisions of existing seasonal dredging restrictions in a manner that supports more efficient regulation of dredging activities while still effectively maintaining a risk-averse approach to protecting winter flounder resources.

Seasonal dredging constraints based on the 2001 conservation recommendation letter have had cost, schedule, navigation safety, environmental, and construction efficiency implications on the HDP. Seasonal dredging restrictions have the potential to impact construction in channels during an estimated 33% of a given calendar year (approximately 4 months) and thereby prolong construction, which delays critical navigation improvements and prolongs potential impacts to the environment. These delays have implications for navigation safety and Coast Guard imposed navigation restrictions, port terminal and commercial vessel operations, and the ability of dredging contractors to allocate available resources most efficiently.

The aquatic biological data collected during the HDP has been and can be used by both local and regional managers to address larger EFH questions, such as whether the EFH depth designation for winter flounder early life stages should be changed to o 20 meters, which ultimately was not passed by the NEFMC. *The ABS study provides strong scientific evidence and is consistent with existing literature in showing channels are not high value spawning habitat.* The preference for shallow spawning habitat is supported by the key findings that 1) early-stage eggs (stages 1 and 2) were collected at non-channel stations in Lower Bay that were shallower than other Lower Bay stations without early-stage eggs and 2) samples that contained multiple egg stages (presumably from multiple spawning events, which is indicative of spawning sites or sinks) were collected primarily at non-channel stations.

Integration of knowledge gained from extensive historical research on winter flounder biology and the ABS program can assist NOAA and the States to determine science-based restrictions on dredging and other activities in the Harbor such that winter flounder eggs and larvae can be reliably protected while regional and economically critical navigation improvements are ensured.

References

Atlantic States Marine Fisheries Commission (ASMFC). 1998. Assessment of the Southern New England/Mid-Atlantic and Gulf of Maine Winter Flounder Stocks. A report by the ASMFC's Winter Flounder Technical Committee.

Bohlen, W.F., M.M. Howard-Strobel, D.R. Cohen and E.T. Morton. 1996. An Investigation of the Dispersion of the Sediments Resuspended by Dredging Operations in New Haven Harbor. U.S. Army Corps of Engineers – New England District. DAMOS Contribution #112.

Keller, A. A. and G. Klein-MacPhee. 2000. Impact of elevated temperature on the growth, survival, and trophic dynamics of winter flounder larvae: a mesocosm study. Canadian Journal of Fisheries and Aquatic Sciences 57:2382-2392.

Laurence, G.C. 1975. Laboratory growth and metabolism of the winter flounder *Pseudopleuronectes americanus* from hatching through metamorphosis at three temperatures. Marine Biology 32: 223-229.

National Research Council. 2001. A Process for Setting, Managing, and Monitoring Environmental Windows for Dredging Projects. Special Report 262. 96 pp.

National Marine Fisheries Service (NMFS). 1999. Essential Fish Habitat Source Document: Winter flounder, *Pseudopleuronectes americanus*, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-138.

National Marine Fisheries Service (NMFS) – Northeast Region. 2001. Conservation Recommendation Letter from Peter D. Colosi, Jr. (Assistant Regional Administrator for Habitat Conservation) to Frank Santomauro (Chief, Planning Division, US Army Corps of Engineers) dated 27 July 2001.

Schultz, E., J.J. Pereira and P.J. Auster. 2007. Determining winter flounder spawning sites in two Connecticut estuaries. Connecticut Department of Environmental Protection.

Sogard, S.M., Able, K.W. and S.M. Hagan. 2001. Long-term assessment of settlement and growth of juvenile winter flounder (*Pseudopleuronectes americanus*) in New Jersey estuaries. Journal of Sea Research 45:189-204.

United States Army Corps of Engineers – New York District (USACE-NYD). 1998. Existing Biological Data for the New York and New Jersey Harbor.

United States Army Corps of Engineers – New York District (USACE-NYD). 2007. Suspended Sediment Plumes Associated With Navigation Dredging In The Arthur Kill Waterway, New Jersey**.** Appendix 3-1 of the Final Environmental Assessment: Effects of the NY/NJ

Harbor Deepening Project on the Remedial Investigation/Feasibility Study of the Newark Bay Study Area. June 2007.

United States Army Corps of Engineers – New York District (USACE-NYD). 2008. Far Field Surveys of Suspended Sediment Plumes Associated With Harbor Deepening Dredging In Newark Bay. September 2008.

United States Army Corps of Engineers – New York District (USACE-NYD). 2010. Application of Winter Flounder Early Life History Data to Seasonal Dredging Constraints and Essential Fish Habitat Designations. November 2010.

Vonderweidt, C., A. Weber, and S. Sherman. 2006. Review of the Atlantic States Marine Fisheries Commission's Interstate Fishery Management Plan for Winter Flounder. Atlantic States Marine Fisheries Commission.

Wilber, D. H., Clarke, D. G., Gallo, J., Alcoba, C. J., Dilorenzo, A. M., and S. E. Zappala. 2013. Identification of winter flounder (*Pseudopleuronectes americanus*) estuarine spawning habitat and factors influencing egg and larval distributions. Estuaries and Coasts. DOI 10.1007/s12237-013-9642-z.

Williams, G.C. 1975. Viable embryogenesis of the winter flounder *Pseudopleuronectes americanus* from -1.8^{o} to 15^{o}C. Marine Biology 33.

Table 1. Percentage of annual egg collections at each station (2002-2011). Empty cells indicate no sampling, whereas zeros indicate no eggs were collected. Type indicates channel (CH) or non-channel/shallow (NC) stations. Stations at the bottom were added to the ABS program to address specific agency questions. Shaded cells indicate multiple-stage eggs in single samples.

Station	Type	Area	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Ave. %
PJ-2	NC	UB	24	0	0	47	41	12	6	22	36	3	20
PJ-3	NC	UB	1	3	0	0	31	25	80				20
LB-5	NC	LB	31	26	6	0	0	24	0	1	2	0	9
LB-1	NC	LB	23	2	21	1	0	6	0	10	2	2	7
LB-4	CH	LB	9	28	10	10	0	0	0	3	1	5	7
SB-6	CH	UB	1	27	0	9	0	2	2	0	0	0	5
PJ-1	NC	UB	0	1	0	8	0	19	3	0	0	0	3
LB-2	CH	LB	1	1	24	0	3	0	0	0	1	2	3
NB-7	NC	AKNB	4	0	0	9		1	7	2	1	1	3
PJ-5	CH	UB	0	0	0	2	16	0					3
LB-6	CH	LB	3	1	18	0	0	0	0	2	0	0	3
SB-3	NC	UB	0	5	0	2	1	10	0	4	0	0	2
SB-4	CH	UB	1	5	7	4	1	0	0	3	0	0	2
SB-5	CH	UB	0	0	0	2	0	0	0	5	0	0	1
LB-3	NC	LB	2	0	5	0	0	0	0	0	0	0	1
PJ-4	CH	UB	0	0	0	3	2	0	0				1
AK-2	CH	AKNB	0	0	3	0	2	0	0	0	0	0	1
SB-2	NC	UB	0	0	0	4	0	0					1
AK-1	NC	AKNB	0	0	2	0							1
NB-6	CH	AKNB	0	0	3	0	0	0			0	0	0
SB-1	NC	UB	0	0	0	0	2	0					0
NB-3	NC	AKNB	1	0	0	0	0	0					0
AK-4	NC	AKNB	0	0	0	0							0
NB-5	CH	AKNB	0	0	0	0	0	0					0
NB-4	NC	AKNB	0	0	0	0	0	0	0	0	0	0	0
AK-7	NC	AKNB					0						0
AK-3	CH	AKNB	0	0	0	0	0	0	0	0	0	0	0
NB-8	CH	AKNB								0	0	0	
LB-9	NC	LB							0	2	0	0	
LB-8	NC	LB							1	1	1	1	
LB-7	NC	LB							0	0	0		
LB-14	CH	LB							0	1	2	0	
LB-13	NC	LB							1	45	6	13	
LB-12	NC	LB							0	0	8	30	
LB-11	NC	LB							0				
LB-10	NC	LB							0	0	0		
LB-16	NC	LB									35	7	
LBD-15	NCdeep	LB									1		
LBD-17	NCdeep	LB									3		
SB-7	CH	UB									1		
AK-8	CH	AKNB										0	
LB-18	NC	LB										7	
1B-19	NC	LB										3	
LB-20	NC	LB										0	
LB-21	NC	LB										25	

Table 2. Percentage of annual total larval collections at each station (2002-2011). Empty cells indicate no sampling, whereas zeros indicate no eggs were collected. Type indicates channel (CH) or non-channel/shallow (NC) stations. Stations at the bottom were added to the ABS program to address specific agency questions.

Station	Habitat	Area	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Ave. %
LB-3	NC	LB	4	16	20	5	20	53	15	15	7	4	16
LB-1	NC	LB	4	19	5	18	9	3	4	2	16	4	8
LB-4	CH	LB	12	7	11	5	16	2	5	11	3	7	8
LB-5	NC	LB	7	6	9	8	8	10	6	5	6	6	7
LB-6	CH	LB	20	2	7	2	2	4	11	6	3	3	6
SB-6	CH	UB	4	6	4	4	7	1	7	2	6	1	4
SB-1	NC	UB	7	5	1	4	3	2					4
SB-4	CH	UB	5	5	4	6	3	1	2	4	2	7	4
LB-2	CH	LB	7	3	5	3	4	1	2	2	1	5	3
SB-3	NC	UB	3	5	2	6	3	0	1	2	1	6	3
SB-2	NC	UB	4	2	1	4	2	2					2
PJ-5	CH	UB	3	1	2	3	4	1					2
SB-5	CH	UB	2	3	5	2	1	2	1	2	1	1	2
PJ-1	NC	UB	2	1	2	3	3	4	1	2	1	4	2
PJ-4	CH	UB	2	1	4	2	2	2	0				2
PJ-3	NC	UB	1	1	1	6	2	2	1				2
NB-6	CH	AKNB	1	0	4	4	1	0			1	1	2
PJ-2	NC	UB	1	1	1	2	3	3	1	2	3	2	2
NB-3	NC	AKNB	1	1	0	4	1	2					2
AK-2	CH	AKNB	1	1	4	3	1	1	0	1	1	1	2
AK-4	NC	AKNB	1	4	2	1		0					2
AK-3	CH	AKNB	1	3	1	1	1	1	1	3	1	2	1
NB-4	NC	AKNB	2	2	0	2	1	1	0	1	1	2	1
NB-7	NC	AKNB	1	1	1	1		1	1	2	1	0	1
NB-5	CH	AKNB	1	0	2	1	1	1					1
AK-7	NC	AKNB					1						1
AK-1	NC	AKNB	1	2	1	0	0						1
NB-8	CH	AKNB								1	1	1	
LB-7	NC	LB							3	7	4		
LB-8	NC	LB							10	3	4	8	
LB-9	NC	LB							3	1	4	5	
LB-10	NC	LB							4	3	3		
LB-11	NC	LB							2				
LB-12	NC	LB							7	11	11	8	
LB-13	NC	LB							8	7	5	3	
LB-14	CH	LB							3	4	7	2	
LB-16	NC	LB									3	4	
LBD-15	NCdeep	LB									2		
LBD-17	NCdeep	LB									1		
SB-7	CH	UB									1		
AK-8	CH	AKNB										2	
LB-18	NC	LB										1	
LB-19	NC	LB										4	
LB-20	NC	LB										5	
LB-21	NC	LB										3	

Table 3. Summary of environmental windows by contract area for the Harbor Deepening Project.

Channel Reach	Letter Date	State Issued	Window Dates	Reason	Specific Location
S-NB-1	8-Sep-06	NJ	1 February - 31 May	Dredging of soft, fine-grained material is prohibited in any given year	Acceptance Areas A1, A2, B1 and B2
			31 March - 31 May	Dredging of all other material in any given year to protect the early life stages of winter flounder	Acceptance Areas A1, A2, B1 and B2
	29-Nov-07	NJ	1 February - 31 May	Dredging of soft, fine-grained material is prohibited in any given year	Outer Side Slope Acceptance Area
			31 March - 31 May	Dredging of all other material in any given year to protect the early life stages of winter flounder	within the Outer Side Slope Acceptance Area
S-NB-2	10-May-10	NJ	15 February - 20 May	Dredging is prohibited in any given year to protect the early life stages of winter flounder	S-NB-2: 500' from the top of slope of the federal navigation channels in proximity to the intertidal flats adjacent to Bayonne, NJ and adjacent to the intertidal flats in Elizabeth, NJ
			15 March - 15 August	No blasting and/or dredging activity shall occur & the NY District shall use marker buoys every 200 ft or less to indicate the 1,000 ft restricted area	within 1,000 ft of any osprey nest
			1 April – 31 July	If nesting is confirmed, no blasting and/or dredging activity shall occur & the NY District shall use marker buoys every 200 ft or less to indicate the 1,000 ft restricted area	within 1,000 ft of Shooter's Island

Channel Reach	Letter Date	State Issued	Window Dates	Reason	Specific Location
	16-Nov-10	NJ	15 February - 20 May	Dredging is prohibited in any given year to protect the early life stages of winter flounder	500' from the top of slope of the federal navigation channels in acceptance areas 1, 3 and 4. This does not apply to acceptance areas 2 and 5.
S-E-1	26-Sep-08	NJ	None		
S-AK-1	10-May-10	NJ	15 February - 20 May	Dredging is prohibited in any given year to protect the early life stages of winter flounder	
			1 April - 31 July	If nesting is confirmed, no blasting and/or dredging activity shall occur & the NY District shall use marker buoys every 200 ft or less to indicate the 1,000 ft restricted area	within 1,000 ft of Shooter's Island
	16-Nov-10	NJ	15 February - 20 May	Dredging of holocene ages sediments dredging is prohibited in any given year to protect the early life stages of winter flounder	
			1 March - 20 May	Dredging and blasting of pleistocene age sediments is prohibited in an given year to protect the early life stages of winter flounder	
S-AK-2	20-Jul-11	NY	15 March - 31 May	For the purpose of protecting early life stages of winter flounder, dredging of predominantly unconsolidated fine grained sediment is prohibited.	
	15-Jul-11	NJ	15 March - 31 May	Dredging of any non-HARS suitable material under this contract is prohibited March 15th through May 31st of any given year to protect the early life stages of winter flounder	

Channel Reach	Letter Date	State Issued	Window Dates	Reason	Specific Location
	13-Mar-12	NJ	20 April - 31 May	Extension of the environmental window imposed on the dredging of non-HARS material from S-AK-2 to allow for dredging to continue until April 20, 2012	
S-AK-3	15-Nov-12	NJ	15 March - 31 May	Dredging of any non-HARS suitable material under this contract is prohibited March 15th through May 31st of any given year to protect the early life stages of winter flounder	
	14 Nov 2012	NY	15 March - 31 May	Dredging is prohibited between March 15th and May 31st in areas that consist of fine grained, unconsolidated silt in layers greater than 6 inches thick	
S-KVK-1	30-Nov-07	NJ	1 February - 31 May	Dredging is prohibited for the following sediment types: Holocene sand, Holocene black silt and Pleistocene sand and gravel to protect the early life stages of winter flounder	Acceptance Areas east of the line 611.000 (Station 32+00 to Station 0+00)
	18-Dec-07	NY			
	18-Apr-08	NY			
S-KVK-2	15-Oct-04	NY	15 November - 31 May	Dredging of non-Hars material is prohibited for protection of winter flounder	NY waters west of the Bayonne Bridge
			1 April - 31 July	If nesting is confirmed on Shooters Island, dredging and/or blasting activity is prohibited & Permittee shall use marker buoys every 200 ft or less to indicate the 1,000 ft restricted area	within 1,000 feet of the island
	17-Nov-04	NJ	1 April - 31 July	If nesting is confirmed on Shooters Island, dredging and/or blasting activity is prohibited	within 1,000 feet of the island

Channel Reach	Letter Date	State Issued	Window Dates	Reason	Specific Location
	21-Apr-05	NY	1 February - 31 May	Dredging of non-Hars material is prohibited for protection of winter flounder	NY waters west of the Bayonne Bridge
S-PJ-1	24-May-05	NJ	1 February - 31 May	Dredging is prohibited of any given year to protect winter flounder early life stages	within the lateral extent of the contract areas 2A and 2B
PJ-3					
S-AN-1	25-Jul-06	NY	1 February - 31 May	Dredging is prohibited	In the area between stations 105+00 and 140+00
S-AN-1A	22-May-08	NY	1 February - 22 May	Dredging is prohibited	In the area between stations 105+00 and 140+00
S-AN-1B	6-May-08	NY	None		
S-AN-2	7-Aug-09	NY			Reach 3
	19-Nov-09	NY			Reaches 1 & 2
	23-Nov-09	NJ	1 February - 31 May	Dredging is prohibited to protect the early life stages of winter flounder	Any portion of Reach 1 & Reach 2 above the confluence of the Kill Van Kull
	24-Nov-09	NY	1 February - 31 May	Dredging is prohibited	Reaches 1 & 2
S-AM-1	17-Mar-05	NJ	None		

Channel Reach	Letter Date	State Issued	Window Dates	Reason	Specific Location
	28-Mar-05	NY	None	Material is >90% sand; there are no operational or seasonal restrictions	
S-AM-2	6-May-08	NY	None		
S-AM-3A	NA		None	Work done under WQCs for S-AM-1 & S-AM-2 because in same physical footprint	
S-AM-3B	NA		None	Work done under WQCs for S-AM-1 & S-AM-2 because in same physical footprint	

Table 4. Summary of winter flounder EFH parameters.

Life Stage	EFH General Habitat Parameters				
	Water Temp (°C)	Salinity (‰)	Water Depth (m)	Seasonal Occurrence/Peak Abundance	Comments
Eggs	<10	10-30	<5	Feb-June	Inshore areas from Gulf of Maine to Mid-Atlantic in bottom habitats with a substrate of sand, mud or gravel.
Larvae	<15	4-30	<6	Mar-July	Pelagic and bottom waters inshore from Gulf of Maine to Mid-Atlantic.
Juveniles	<25	10-30	1-50	*	Bottom habitats with a substrate of mud or fine-grained sand.
Adults	<25	15-33	1-100	*	Bottom habitats including estuaries with mud, sand or gravel substrate.
Spawning Adults	<15	5.5-36	<6	Feb-June	Bottom habitats including estuaries with mud, sand or gravel substrate.
Source: New England Fishery Management Council EFH Amendment document accessed at http://www.nero.noaa.gov/hcd/winter.pdf					

* Note the NEFMC EFH Amendment document does not specify a seasonal occurrence/peak abundance for juveniles and adults

Table 5. Harbor Deepening Project and EFH coordination timeline.

1996	The Water Resources Development Act (WRDA) authorizes USACE to investigate alternatives for navigation improvement in the Harbor.
1998	Baseline biological sampling (bottom trawls and ichthyoplankton tows) begins as a systematic program that eventually develop into the Aquatic Biological Survey (ABS).
1999	The Feasibility Report for the Harbor Navigation Study (HNS) and Final Environmental Impact Statement (FEIS) are published which includes a harbor-wide EFH assessment.
2001	National Marine Fisheries Service (NMFS) issues its EFH conservation recommendations (CR) for the proposed Harbor Navigation Project that includes seasonal work constraints for certain channels based on location, sediment characteristics, and the temporal use of the project area by early life stage (eggs and larvae) winter flounder.
2002	ABS sampling locations are added to the Lower Bay to provide a comprehensive survey of the entire project area.
2003	NMFS reviews the Limited Reevaluation Report (LRR) and the draft Environmental Assessment (EA) and issues a CR for the Consolidated Implementation of the Harbor Deepening Project (HDP).
2007	New England Fishery Management Council (NEFMC) releases a draft EIS for the proposed re-designation of winter flounder EFH from the current 5 and 6 meters for eggs and larvae, respectively, to 20 meters.
	Staging of winter flounder larvae based on developmental characteristics is added to the laboratory methodology of the ABS.
2008	New ABS sampling stations are added in the KVK to address seasonal dredge constraints added to the water quality certifications of the HDP contract area S-KVK-1. ABS technical team presents ABS data at Flatfish Biology Conference in Plymouth, MA.
2009	ABS technical team meets with NMFS (Gloucester, MA) and the NEFMC Habitat PDT to present ABS data for further review and consideration regarding the draft EIS.
	Three new sampling locations are added in the Lower Bay to address NEFMC Habitat PDT questions about egg and larval densities at natural deep versus channelized deep water.
	USACE-NYD submits a Technical Memorandum (Depth vs. Density analysis) to NMFS.
	NEFMC files NOI to prepare one final EIS that combines both phases of the Omnibus Amendment.
2010	USACE-NYD meets with NMFS to discuss reinitiating formal EFH coordination for revised HDP Conservation Recommendations, in light of the extensive ABS dataset and to re-establish proper coordination and collaboration processes.
	NYD ABS technical team prepares an EFH Summary Report to summarize ABS dataset, and other data sources, for use in adaptive management applications to support the NAD navigation program.
	NEMFC voted to not change the EFH depth designation for winter flounder early life history stages.

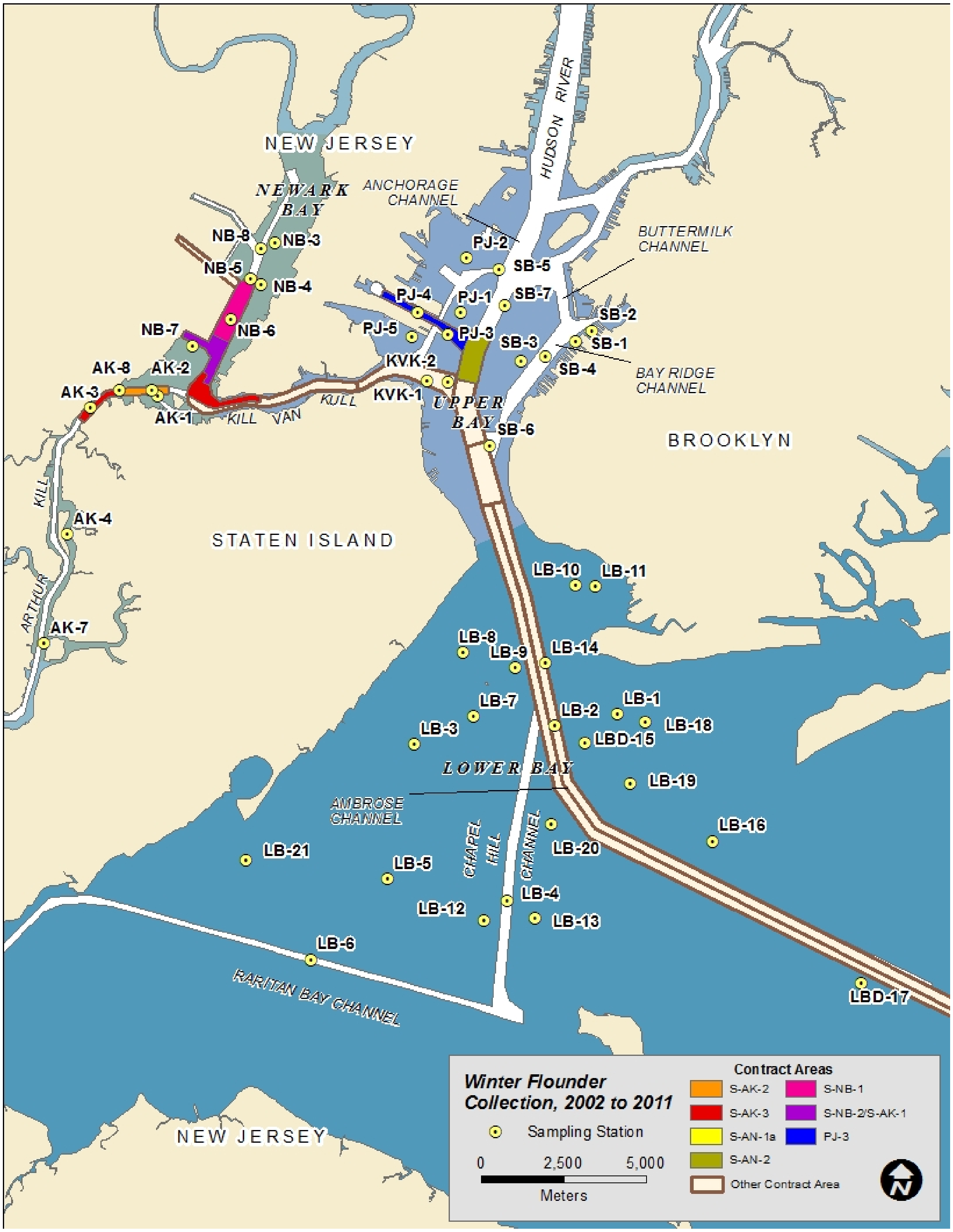


Figure 1. Ichthyoplankton sampling locations during the 2002-2011 ABS with HDP contract areas.

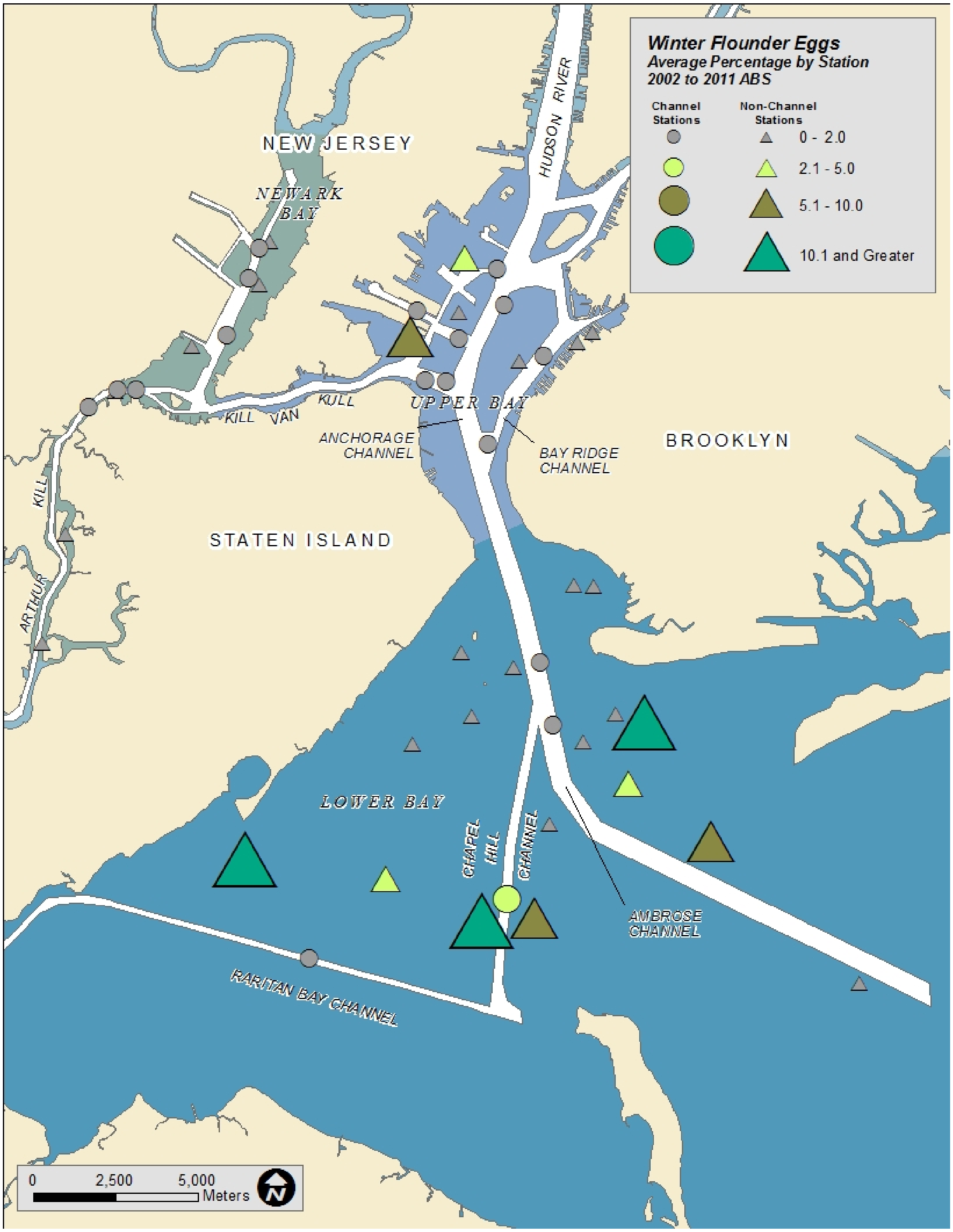


Figure 2. Average percentage of collection by station for winter flounder eggs during the 2002-2011 ABS for channel (circles) and non-channel (triangles) stations based on the all year average shown in Table 1.

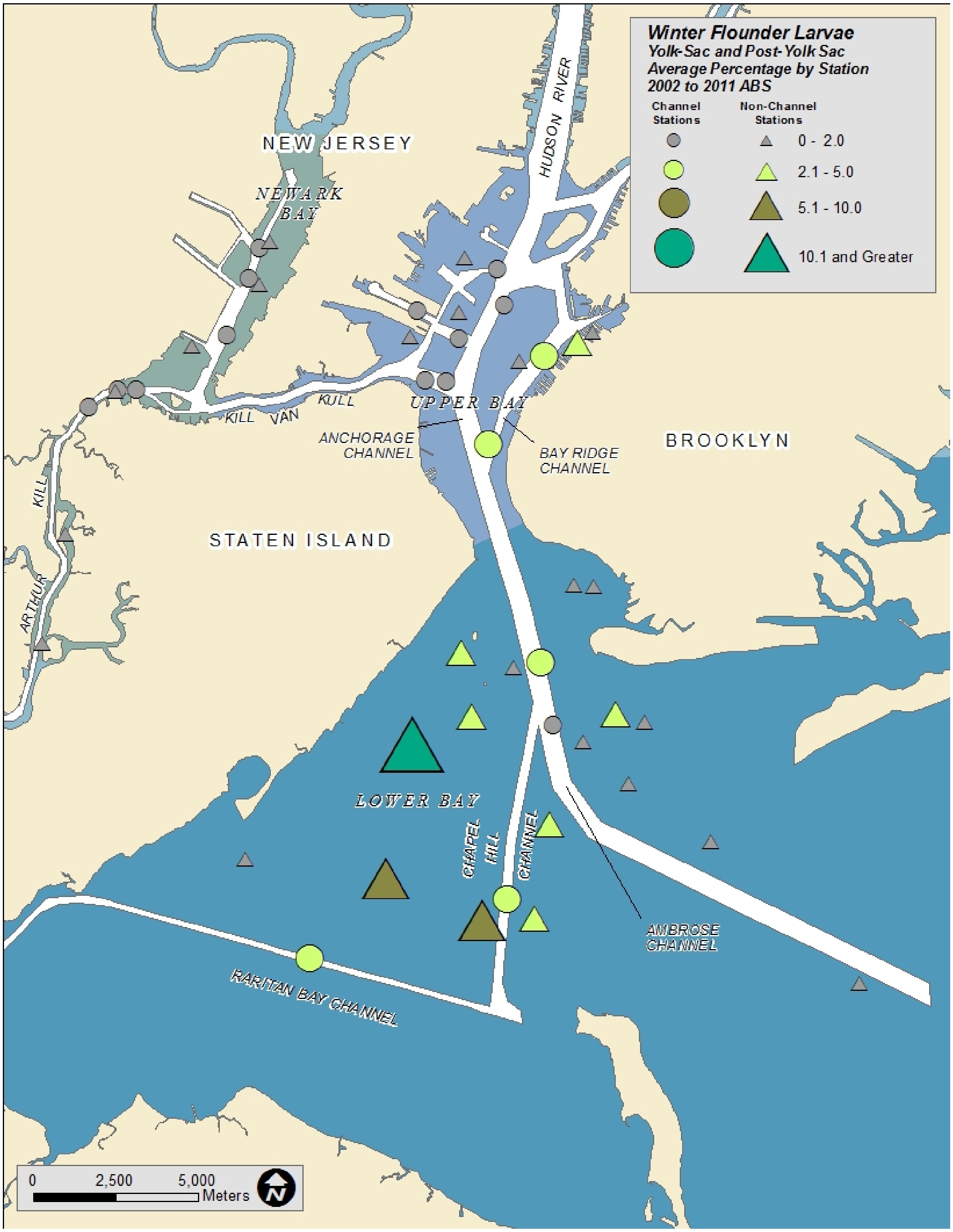
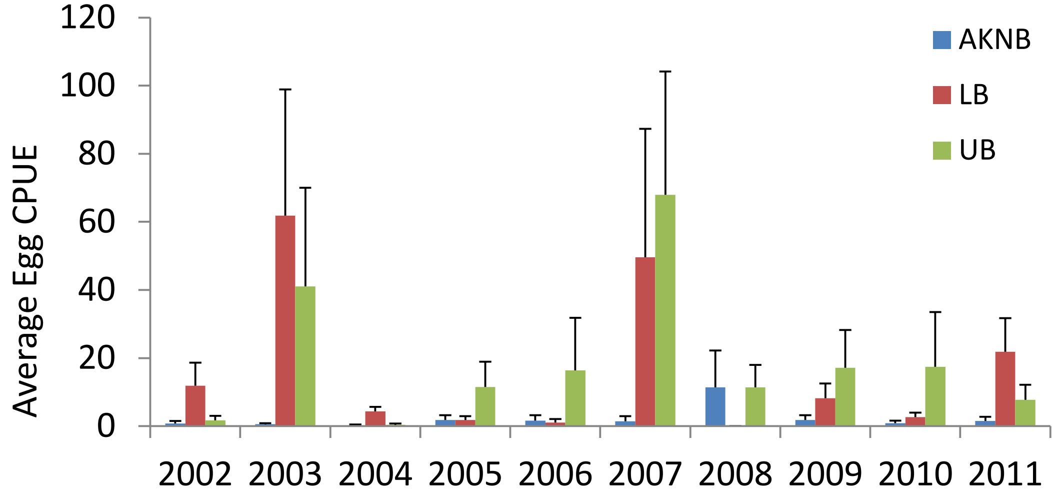
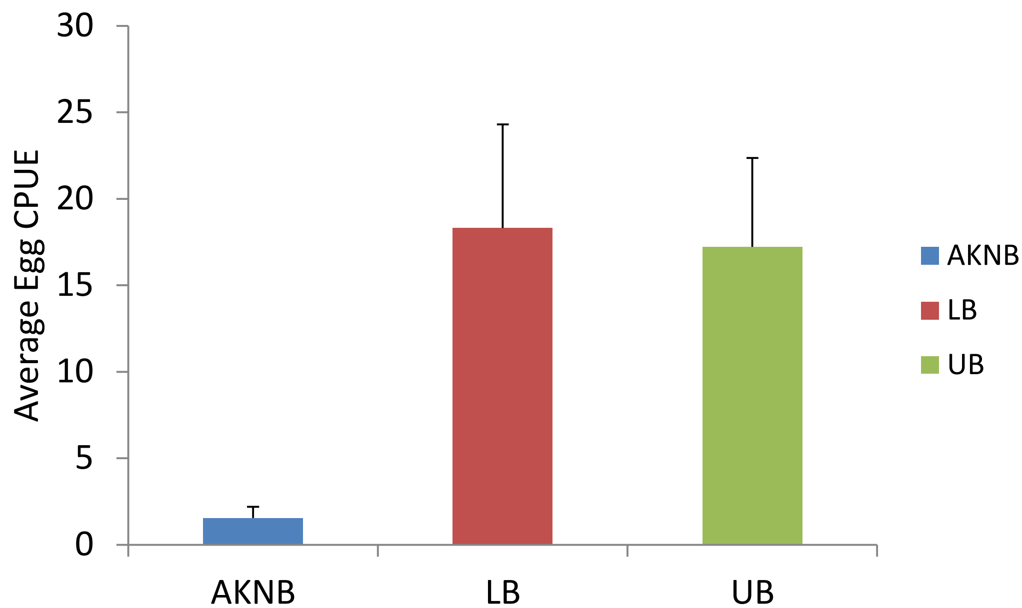


Figure 3. Average percentage of collection by station for winter flounder larvae (yolk-sac and post-yolk-sac) during the 2002-2011 ABS for channel (circles) and non-channel (triangles) stations based on the all year average shown in Table 2.



a.



b.

Figure 4. Average (+ standard error) egg densities (per 1,000 m^3) collected at core (sampled every year) stations in Arthur Kill/Newark Bay (AKNB), Lower Bay (LB), and Upper Bay (UB) during the spawning season for (a) each year and (b) the ten year study period (2002-2011).

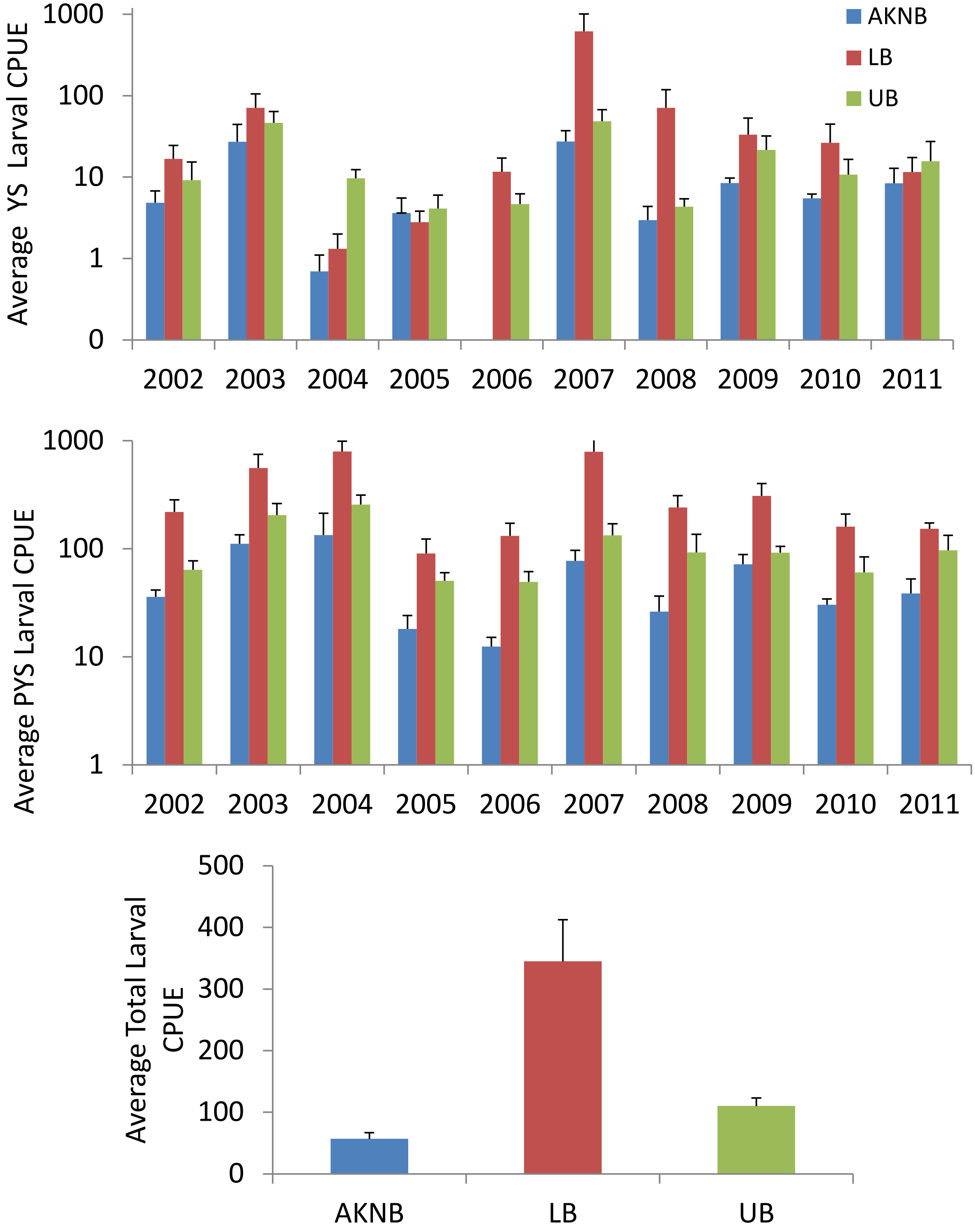


Figure 5. Average (+ standard error) densities (per 1,000 m^3) of (a) yolk-sac and (b) post-yolk-sac larvae, and (c) total larvae collected core stations in Arthur Kill/Newark (AK/NB) Bay, Lower Bay (LB), and Upper Bay (UB) for 2002 to 2011.

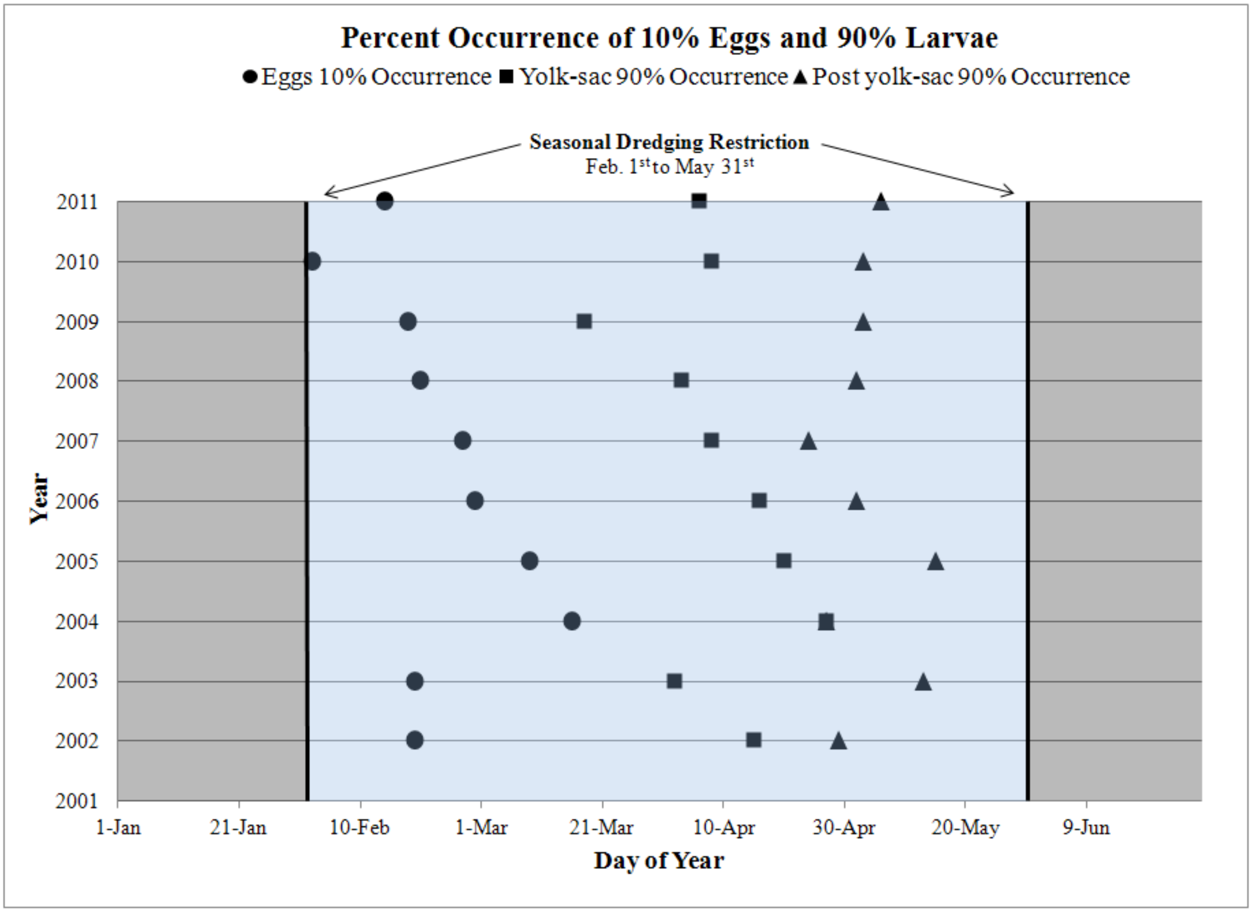


Figure 6. Dates by which 10% of eggs (circles) and 90% of yolk-sac (squares) and post-yolk-sac (triangles) larvae were collected from 2002 to 2011 for all Harbor stations.

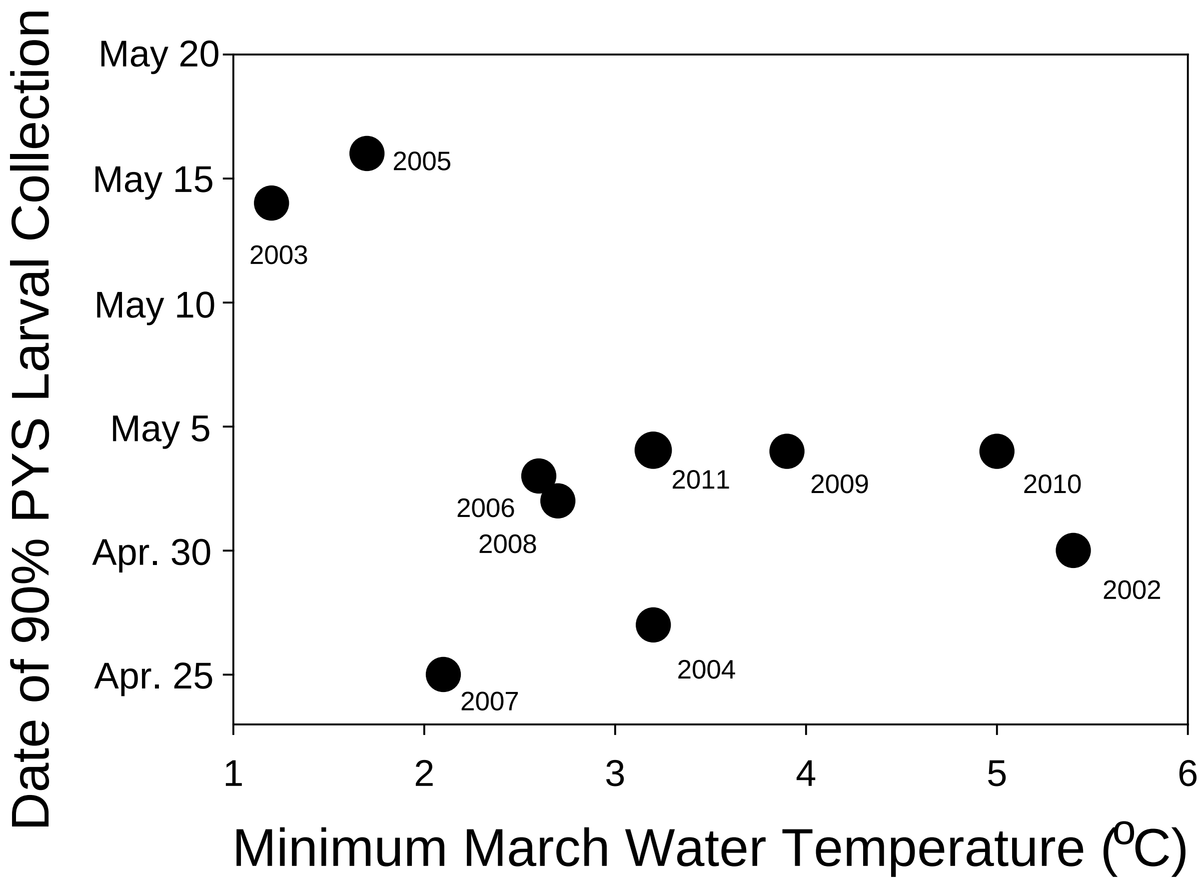


Figure 7. Correlation between minimum March water temperatures (NOAA station 8518750 located at the Battery) and the date at which 90% of post-yolk-sac larvae were collected each year.

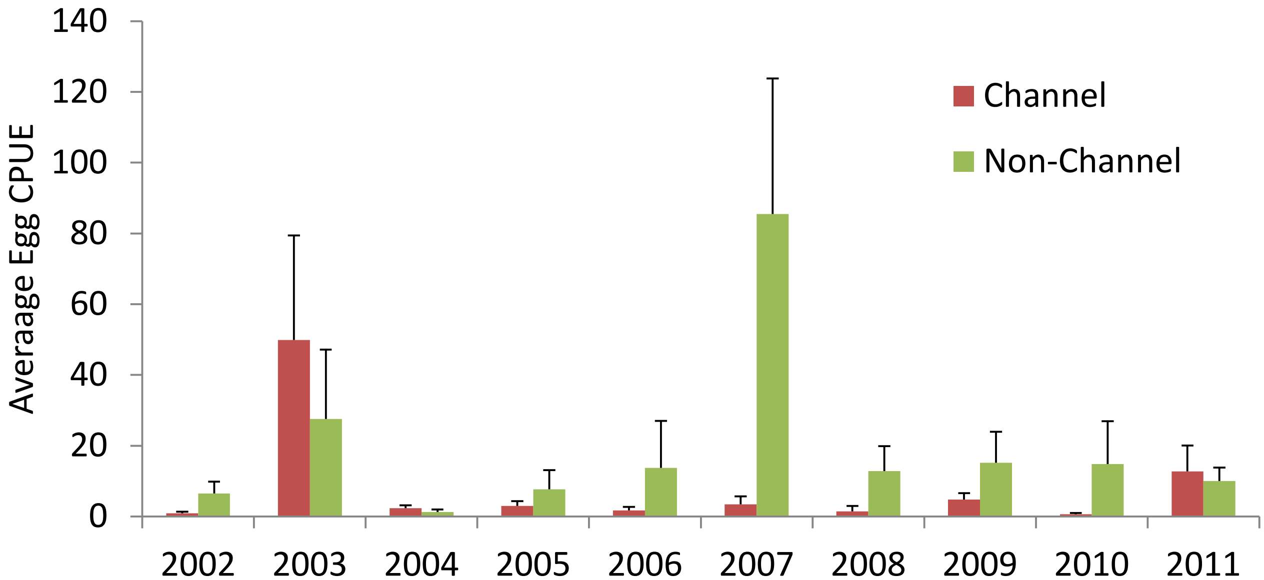


Figure 8. Average (+ standard error) densities (per 1,000 m^3) of eggs collected at core (sampled every year) channel (red bars) and non-channel (green bars) stations for all years of sampling.

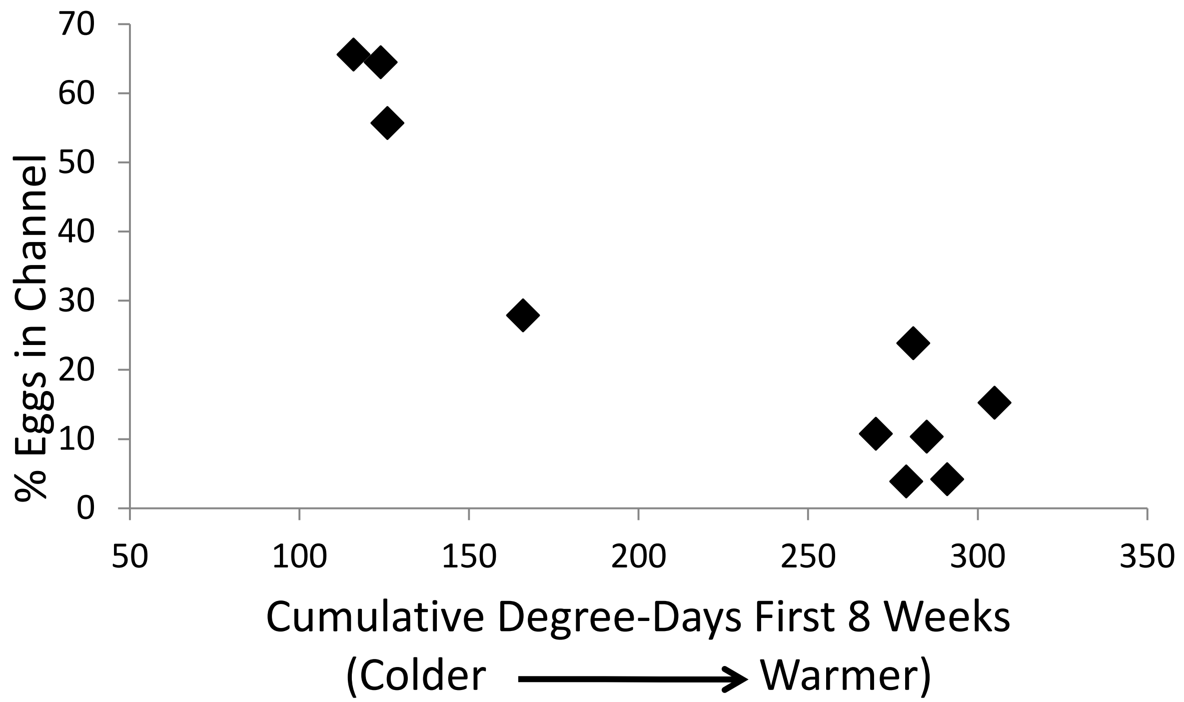


Figure 9. Annual % of eggs collected at core (sampled every year) channel stations (2002 – 2011) vs. the cumulative degree days for the first 8 weeks of each year (Spearman r = - 0.78, p < 0.01).