FMAT Working Paper (DO NOT CITE) **9/15/2011**

Part I. Analyses for Amendment 14 to the Atlantic mackerel, squid and butterfish Fishery Management Plan

1.0 Survey relative abundance and biomass indices

1.1 Background

The Atlantic States Marine Fisheries Commission (ASMFC) is currently conducting a river herring (*Alosa pseudoharengus*, alewife, and *Alosa aestivalis*, blueback herring) stock assessment, but the results are not yet available. The most recent stock assessment of American shad (*Alosa sappidissima*) was conducted using data through 2005 (ASMFC 2007), but hickory shad *Alosa mediocris* has not been assessed. Therefore, in order to evaluate trends in oceanic population sizes, relative abundance and biomass indices were derived for these species using catch data from research bottom trawl surveys conducted by the NEFSC on the eastern US continental shelf. These anadromous species spend most of their lives in oceanic waters but migrate into freshwater to spawn.

The oceanic ranges of all four species extend beyond the northern and southern latitudinal range of the NEFSC spring and fall surveys, which occur from the Gulf of Maine to Cape Hatteras, NC (35° 30' to 44° 30' N). The geographic range of blueback herring in the northwest Atlantic extends from Cape Breton, Nova Scotia, to the St. Johns River in FL and the range of American shad extends from the Sand Hill River in Labrador to the St. John's River in FL (Page and Burr 1991). The geographic range of alewife extends from Red Bay, Labrador, to SC. Hickory shad have a narrower geographic range than these three species and is most abundant between Cape Cod, MA and the St. John's River in FL, but is also infrequently found in the Gulf of Maine (Munroe 2002).

1.2 Methods

The NEFSC conducts annual bottom trawl surveys, between the Gulf of Maine and Cape Hatteras, North Carolina, using a stratified random design. Standardized tows were conducted for 30 minutes at 3.5 knots until 2009 when a new research vessel replaced the SRV *Albatross IV* and the towing protocol changed to a duration of 20 minutes at 3.0 knots. Details regarding the survey design and sampling protocols are described in Azarovitz (1981). Inshore strata (8-27 m) and offshore strata (27-366 m) have been most consistently sampled by the SRVs *Albatross IV* and *Delaware II* since the fall of 1975 and spring of 1976. Prior to these time periods, either only a portion of the survey area was sampled or a different vessel and gear were used to sample the inshore strata (Azarovitz 1981). Although winter surveys (February) were conducted during 1992-2007, the sampling area only covered a subset of offshore strata (e.g., no sampling in the Gulf of Maine) and employed sampling gear different from that used during the spring and fall surveys.

Indices of relative abundance (stratified mean number per tow) and biomass (stratified mean kg per tow) were derived, for alewife, blueback herring, and American shad, using data from NEFSC spring (1976-2011) and fall (1975-2010) bottom trawl surveys. Indices were not computed for hickory shad because the species was caught in low numbers at only a few stations during a few years (i.e., at 18 stations during 9 years and at 16 stations during 10 years for the spring and fall surveys, respectively). For the time series utilized, sampling during the fall and spring surveys generally occurred during September-November and March-April, respectively, in a south to north direction (Figure 1).

Catches from all inshore and offshore survey strata located between Cape Hatteras, NC and the northern Gulf of Maine (Figure 1) were used to compute the survey indices for each of three species because preliminary evaluations of the spatial distribution of each species indicated high degrees of interannual variability. In addition, both tagging data (Boreman 1981) and correlation analyses (ASMFC 2008) suggest riverine stocks become mixed within their oceanic habitat. For most of the blueback and alewife time series analyzed, correlation coefficients were not significant for comparisons between time series of New England run sizes and spring survey relative abundance indices for nearby coastal areas, the latter which included indices derived from two subsets of NEFSC survey strata.

Beginning in 2009, the SRV *H. B. Bigelow* replaced the SRV *Albatross IV* as the primary survey vessel. As a result, the two shallowest series of inshore strata (8-18 m depths) are no longer sampled due to the deeper draft of the *Bigelow*. These inshore strata constitute important habitat during both the fall and spring survey periods for all of the species analyzed herein. Since the fall of 2007, inshore areas of 6.1 to 18.3 m have been sampled during a separate bottom trawl survey, the Northeast Area Monitoring and Assessment Program (NEAMAP) survey, conducted between Long Island and Cape Hatteras, NC. The NEAMAP survey is conducted during the fall (late Sept.-mid-Oct., which is similar to the timing of the NEFSC fall survey) and during spring (late April-mid-May, which is later than the NEFSC spring survey. Approximately 150 stations are sampled with fourteen of the stations located in Block Island Sound and Rhode Island Sound at slightly deeper depths of 18.3 m to 36.6 m (Bonzek et al. 2009). The cruise track is from south to north during spring surveys and from north to south during fall surveys. The NEAMAP surveys are conducted between sunrise and sunset and use the same towing protocol (20 minutes at 3.0 knots) that has been used since 2009 to conduct the NEFSC surveys. Although a different vessel is used during the NEAMAP surveys, the gear is the same as that used by the *Bigelow*, with the exception of a 3-inch cookie sweep rather than the rockhopper sweep used by the *Bigelow*. There are no calibration factors available with which to convert the NEAMAP survey catches to *Bigelow* catches. However, swept-area biomass estimates from the spring and fall NEAMAP surveys were available and are presented herein along with the length compositions of the catches (C. Bonzek, pers. comm.).

1.2.1 Catch conversion factors

Vessel, door and net changes have occurred during the NEFSC bottom trawl surveys, resulting in the need for conversion factors to adjust the survey catches for some species. A Yankee #36 net was used to conduct the spring and fall surveys, with the exception of spring surveys conducted during 1973-1981 for which a Yankee #41 net was used. A trawl door change occurred in 1985. However, there are no net or door conversion factors available to adjust the survey indices for the three species being evaluated herein. During some years, both the SRV *Albatross IV* and the SRV *Delaware II* were used to conduct the surveys. However, a vessel conversion factor is only available for alewife. A vessel conversion factor of 0.58 was applied to the alewife weight per tow indices. Alewife number per tow indices did not require a conversion factor because there was no significant difference between the numbers of alewife caught by each vessel (Byrne and Forrester 1991).

Beginning in 2009, the NEFSC SRV *Albatross IV* was replaced with the SRV *Henry B. Bigelow*. The new vessel is quieter and the increased headrope height of the Bigelow's net has improved the catchability of pelagic species like those being evaluated herein. In order to extend the NEFSC spring and fall survey time series beyond 2008, vessel calibration factors were applied to the *Bigelow* catches of each of the three species to convert them to *Albatross* equivalents. Bottom trawl catches of the subject alosid species tend to be higher during the daytime because of diel migration patterns (Neves and Despres 1979; Loesch et al. 1982; Stone and Jessop 1992). Additional variance is associated with time-of-day conversion factors used to adjust nighttime catches to daytime equivalents. In addition, the time-of-day used to separate "day" tows from "night" tows is most often arbitrarily selected. In order to avoid these pitfalls, only daytime tows were used to compute the relative abundance and biomass indices. Daytime tows (i.e., tows between sunrise and sunset) were defined based on solar zenith angle. Sunrise and sunset were determined for each survey station based on sampling date, location, and solar zenith angle using the method of Jacobson et al. 2011. Although there is a clear general relationship between solar zenith and time of day, tows carried out at the same time but at different geographic locations may have substantially different irradiance levels that might affect survey catchability to different extents (NEFSC 2011). Daytime catch number and weight calibration factors (Table 1) were computed for alewife and blueback herring using the method of Miller et al. (2010) and were applied to survey indices from 2009 onward to convert SRV *Bigelow* catches to SRV *Albatross* equivalents. The calibration factors were combined across seasons due to the low within-season sample sizes from the 2008 calibration studies (i.e., < 30 tows with positive catches by one or both vessels). American shad were caught in fewer than 30 tows during each of the 2008 calibration studies, so estimates of daytime-based conversion factors were not possible. Instead, American shad indices for 2009 onward were converted to *Albatross* equivalents using conversion factors based on all tows regardless of when they occurred.

The NEFSC survey database contained some records with catches of a small number of individuals for which the catch weight data are missing. For such records, which occurred primarily during the spring surveys, the spring numbers-at-length were converted to catch weight values using species-specific spring survey length-weight equations (Table 2).

1.3 Results and Discussion

1.3.1 Survey indices

NEFSC spring surveys occur during March and April when mature individuals, for the subject anadromous species, are migrating shoreward and into rivers and streams to spawn. The timing of spring spawning migrations into freshwater occurs earliest in the southern portion of each species' geographic range then progress northward and blueback herring generally spawn later in the spring than alewives (Boreman 1981). Latitudinal trends in fall emigration patterns also occur. Juvenile American shad emigrate seaward during the fall from northern rivers first and those from southern areas emigrate progressively later (Leggett 1977). A similar north-to-south emigration trend exists for river herring, but alewives emigrate before blueback herring (Boreman 1981). The NEFSC survey cruise track follows a general south to north direction during both the spring and fall surveys. The distribution of each species during the spring and fall surveys depends on the timing of the survey in relation to the timing of seasonal and annual migration patterns of each of the four subject species. The timing of the NEFSC spring and fall surveys has been variable and this may have affected availability of the subject species to the survey gear. During most years, the mean Julian dates of the fall surveys ranged between 270 and 290 and ranged between 84 and 102 for the spring surveys. The spring and fall spatial distributions of each species are described below in Section 2.0.

Relative abundance and biomass indices could not be computed for hickory shad because catch rates for both surveys were very low during the few years for which the species was caught (Figure 2). For the other three species, spring and fall survey indices exhibited considerable inter-annual variability, and in general, were more informative for the spring surveys because each of the species was caught at more stations (Figures 3-5). Consequently, the precision of the spring survey indices was higher than for the fall survey indices (Tables 3-8). Fall relative abundance of blueback herring has been above the median since 2002 and the 2009 and 2010 indices were the highest of the time series (Figure 3). Spring relative abundance has been above the median since 2006. Alewives were caught at more stations and in higher numbers than blueback herring and an obvious increase in fall relative abundance was evident for 2008-2010; the highest three years of the time series (Figure 4). Spring relative abundance of alewives was above the median during 2008-2011 and was the highest of the time series in 2011. Interannual variability in the fall relative abundance of American shad was extremely high, but has been above the median during most years since 1992 (Figure 5). Spring relative abundance of

American shad has fluctuated above and below the median for multi-year periods and was highest during 1990-1997, but then declined through 2005 but has generally been above the median since 2006 (Figure 5).

Swept area abundance (log number per 25,000 m^2) and biomass (log kg per 25,000 m^2) estimates of blueback herring, alewife and American shad were available for spring NEAMAP surveys during 2008-2011, but were only available for alewives during the fall (2007-2010) surveys because fall catch rates of blueback herring and American shad were too low (Figures 6-8). Only the fall 2010 abundance estimate for alewife was significantly different from the rest of the values in its respective time series (Figure 7). The NEAMAP time series is short, and because it only covers a small portion of the entire survey area, it is not clear whether the indices are measuring relative abundance within the NEAMAP survey area or migrations between the NEAMAP and NEFSC survey areas or between the NEAMAP strata and estuarine habitat of the subject species. For example, distribution maps from a seasonal, stratified random bottom trawl survey conducted in the Hudson-Raritan estuary, during 1992-1997, indicate that river herring utilize this estuarine habitat during the time that the spring and fall NEAMAP and NEFSC surveys are conducted and were not present in the estuary during the summer (NEFSC 1998).

1.3.2 Survey length compositions

Length compositions of the survey catches during the 1976-2008 spring and fall surveys are shown as stratified mean numbers per tow for each of the three species. Fall survey length distributions of blueback herring (modes at 15 and 24 cm FL) and alewife (modes at 18 and 23 cm FL) were bimodal. Similar size modes were present during the spring surveys, but a third mode of smaller individuals (at 9 cm for blueback and 11 cm for alewife) was also present (Figure 9). Limited data from age-length keys for NEFSC spring surveys indicate that the 9 and 11 cm modal groups consist of age 1 fish. Spring NEAMAP survey catches of blueback herring are dominated by age 1 fish which were caught in very large numbers during the 2011 spring survey (Figure 10). Age 0 fish were not present in either the NEAMAP or NEFSC surveys. Age data for blueback herring caught in NEFSC fall surveys is lacking.

American shad length distributions were unimodal during the fall surveys (mode at 22 cm FL) and bimodal during the spring surveys, with modes at 16 and 25 cm FL (Figure 9). There are no age data from NEFSC surveys for either of the shad species. The spring NEAMAP survey catches of American shad were dominated by small fish within the 13 cm modal size group and also consisted of a second modal size group of 20 cm (Figure 10).

2.0 Species-specific seasonal and interannual spatial distributions

2.1 Background

Limited tagging studies indicate that extensive coastwide migrations are undertaken by river herring (Boreman 1981). For example, a blueback herring tagged off South Carolina was recovered as far north as Cape Cod (Curtis 1971). American shad also undergo lengthy migrations. Shad tagged in the Gulf of Maine, where they spend the summer and fall, were recovered in areas located between Quebec and Georgia (Cheek 1968).

2.2 Methods

Several methods were used to characterize the seasonal and annual spatial distribution patterns of American shad, hickory shad, alewife and blueback herring on the Northeast continental shelf using data collected during NEFSC and NEAMAP surveys. Catch rate data included in the spatial analyses include numbers per tow from the 1976-2010 spring surveys and the 1975-2010 fall surveys for the same set of strata used to compute relative abundance and biomass indices. As explained above in Section 1.2, data from surveys conducted prior to these time periods were excluded from the analyses because important habitat of the subject species was either not sampled or sampled by a vessel for which conversion factors are not available.

Maps of density data, including tows with zero catch, collected during NEFSC and NEAMAP (2009 onward) surveys were generated for each year of the spring and fall time series, as well as for the spring and fall time series, using ArcGIS v. 10 © ESRI. A spatial statistical tool, the standard deviational ellipse, was used to characterize the interannual variability in the spatial distributions of each species as well as to define the geographical extents of the distribution time series for each species. The method involves computation of the standard deviation of the latitudinal and longitudinal coordinates from the mean center of the density distribution to define the axes of the ellipse and thereby define the orientation of the distribution. Each ellipse encompasses one standard deviation, or 68% of all density values, from the centroid of the distribution.

A second method was used to define offshore habitat areas with the highest cumulative densities of each species for the spring and fall survey time series. The same method, which involves post-stratification of the NEFSC and NEAMAP survey data, was previously used to generate Essential Fish Habitat maps for Amendment 11 to the MSB FMP (MAFMC 2011). NEFSC and NEAMAP catch rate data were mapped by ten-minute square (TNMS) as cumulative percentages (75, 90, 95, and 100%) of the back-transformed mean catch densities (representing a pseudo-geometric mean). The mean catch density per TNMS ($\bar{d}_j$) was computed as:

$$\bar{d}_j = \sum_{i=1}^{n_j} \frac{(\ln(d_i)+1)_j}{n_j}$$

where $(\ln(d_i)+1)_j$ is the log-transformed density plus 1 at station *i* for TNMS *j* and n_j is the number of stations sampled within each TNMS. Although this method introduces a slight bias, the back-transformed mean of the log(X+1) observations has some resistance to the effects of outliers and reduces potential distortions introduced when large values occur. Skewed catch density distributions, attributable to infrequent, large-magnitude catches, are common for pelagic schooling species such as those being analyzed herein. Mean densities were not computed for TNMS where fewer than four tows were conducted during the time series.

2.3 Results and Discussion

Inter-annual variability in the sizes and locations of the habitat areas occupied by of each of the four species are important considerations for determining whether closed areas would be beneficial in reducing the incidental catches of these species. Maps showing the one standard deviational ellipses for all years combined (red ellipses) suggest that bluebacks, alewives and American shad are distributed across smaller geographic areas during the fall (Figures 11-13), primarily in the western and northern Gulf of Maine and to a lesser extent in southern New England, than during the spring (Figures 14-16). The same maps also show that the “envelopes” of all of the annual standard deviational ellipses for each species (dashed lines) are much larger for the spring time series than for the fall time series, indicating greater inter-annual variability in the sizes and locations of the three species spatial distributions during the spring than during the fall. Catches of hickory shad were very low for both the fall and spring survey time series, and consequently, distributions of the species are only presented as density-per tow maps for each of the two time series (Figures 17 and 18, respectively).

Examples of annual standard deviational ellipse maps, during three consecutive years, show the high degree of interannual variability in the spatial distributions of the subject species, particularly during spring surveys. Figure 19 indicates that alewives are less abundant in the fall NEFSC surveys than during the spring surveys (Figure 20) and that the species is much more broadly distributed during the spring, extending along most of the shelf between the Gulf of Maine and Cape Hatteras, NC. Stations with the highest densities during the spring surveys were broadly dispersed, rather than clustered within small localized areas, and their locations changed annually (e.g., in southern New England during 1996 and 1997 but in also in the Gulf of Maine during 1998). Similarly high levels of interannual variability occurred in the fall and spring spatial distributions of blueback herring (Figures 21 and 22) and American shad (Figures 23 and 24).

Maps showing cumulative percentages (75, 90, 95 and 100%) of the geometric mean densities of *Alosa pseudoharengus, A. aestivalis*, and *A. sapidissima* during the 1975-2010 NEFSC fall bottom trawl surveys indicate that the highest mean densities (75%) of all three species occurred in the western Gulf of Maine and in southern New England south of Cape Cod and east of Long Island (Figure 25). During the spring surveys, the highest mean densities of each species occurred across much broader areas than during the spring surveys, within both the Gulf of Maine and from Cape Cod to Cape Hatteras, NC (Figure 26).

Maps of the spatial distributions of Atlantic mackerel and Atlantic herring indicate that during NEFSC fall bottom trawl surveys, the densities of both species were highest in the Gulf of Maine, but during the spring surveys both species were much more broadly distributed across the continental shelf, between Cape Hatteras and the Gulf of Maine, similar to the spring and fall distributions of the subject bycatch species (Figures 27). The high degree of interannual variability in the spring and fall spatial distributions of all three species is an important consideration with respect to implementation of closed area management measures to reduce the bycatch of these species.

3.0 Literature cited

ASMFC [Atlantic States Marine Fisheries Commission]. 2007. American shad stock assessment report for peer review, Vol. I. Stock Assessment Report No. 01-01 (Supplement). 224 p.

ASMFC [Atlantic States Marine Fisheries Commission]. 2008. 2008 river herring stock status report.662 p.

Azarovitz, T.R. 1981. A brief historical review of the Woods Hole Laboratory trawl survey time series. *In* W. G. Doubleday and D. Rivard, Ed. Bottom trawl surveys. Canadian Special Publication of Fisheries and Aquatic Sciences 58.

Bonzek, C. 2011. Virginia Institute of Marine Science. Pers. comm.

Bonzek, C.F., J. Gartland, J.D. Lange, Jr., and R.J. Latour. 2009. Data collection and analysis in support of single and multispecies stock assessments in the Mid-Atlantic and Southern New England. Submitted to the Atlantic States Marine Fisheries Commission, Washington DC.

Boreman, J. 1981. River herring stocks along the Atlantic coast. Northeast Fisheries Center Lab. Ref. Doc. 81-35. 22 p.

Cheek, R. P. 1968. The American Shad. USFWS. Bureau of Commercial Fisheries. Fishery Leaflet 614, 13 p.

Fuller, P. and G. Jacobs. 2011. *Alosa aestivalis*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=488 RevisionDate: 9/22/2009.

Fuller, P., Maynard, E., and D. Raikow. 2011. *Alosa pseudoharengus*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=490

Jacobson, L.D., A. Seaver and J. Tang. 2011. AstroCalc4R: software to calculate solar zenith angle; time at sunrise, local noon and sunset; and photosynthetically available radiation based on time, date and location. Northeast Fisheries Science Center Lab. Ref. Doc. 11-14, 10 p.

Leggett, W. C. 1977. Ocean migration of American shad (*Alosa sapidissima*). J. Fish. Res. Bd. Can. 34: 1422-1426.

Loesch, J. G., W. H. Kriete and E. J. Foell. 1982. Effects of light intensity on the catchability of juvenile anadromous *Alosa* species. Trans. Am. Fish. Soc. 111: 41-44.

Mid-Atlantic Fishery Management Council (MAFMC). May 2011. Amendment 11 to the Atlantic Mackerel, Squid, and Butterfish (MSB) Fishery Management Plan (FMP). Available at: http://www.mafmc.org/.

Munroe, T. 2002. Herrings. Family Clupeidae. Pages x-x *in* B. B. Collette and G. Klein-MacPhee, Ed. Bigelow and Schroeder's Fishes of the Gulf of Maine, 3rd Edition. Smithsonian Institution Press, Washington, D.C.

Neves, R. J. 1981. Offshore distribution of alewife, *Alosa pseudoharengus,* and blueback herring, *A. aestivalis,* along the Atlantic coast. Fish. Bull. 79(3): 473-485.

Neves, R. J. and L. Depres. 1979. The oceanic migration of American shad, *Alosa sapidissima,* along the Atlantic coast. Fish. Bull. 77(1): 199-212.

NEFSC [Northeast Fisheries Science Center]. 2011. 51st Northeast Regional Stock Assessment Workshop (51st SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 11-02; 856 p.

Page, L. M., and B. M. Burr. 1991. A field guide to freshwater fishes of North America north of Mexico. The Peterson Field Guide Series, Vol. 42. Houghton Mifflin Company, Boston, MA.

Stone, H. H. and B. M. Jessop. 1992. Seasonal distribution of river herring *Alosa pseudoharengus* and *A. aestivalis* off the Atlantic coast of nova Scotia. Fish Bull. 90(2): 90:376-389.

Weaver, C. R. 1965. Observations on the swimming ability of adult American shad *(Alosa sapidissima*). Trans. Am. Fisheries Society 94(4):382-385.

Wilk, S. J., R. A. Pikanowski, D. G. McMillan and E. M. MacHaffie. 1998. Seasonal distribution and abundance of 26 species of fish and megainvertebrates collected in the Hudson-Raritan estuary, January 1992 - December 1997. NEFSC Lab. Ref. Doc. 98-10, 145 p.

Table 1. Calibration factors used to convert daytime (between sunrise and sunset) SRV *Albatross IV* catches to SRV *Henry B. Bigelow* equivalents for NEFSC spring and fall bottom trawl survey catches for 2009 onward.

	Number per tow	SE	Kg per tow	SE
Alewife	1.0532	0.1569	0.7165	0.1127
Blueback herring	0.8706	0.1710	1.5943	0.4456

Table 2. Sample sizes and parameter estimates for NEFSC spring survey length-weight relationships for *Alosa aestivalis*, *Alosa pseudoharengus*, and *Alosa sapidissima*.

Species	ln(a)	b	r^2	N fish
Alosa aestivalis	-12.943	3.4827	0.97	1,532
Alosa pseudoharengus	-12.898	3.5023	0.94	132
Alosa sapidissima	-12.508	3.3323	0.99	780

Table 3. Stratified mean number per tow and mean weight (kg) per tow indices for blueback herring caught during daytime tows (between sunrise and sunset) in NEFSC fall bottom trawl surveys, 1975-2010. CVs for indices from 2009 onward do not account for the additional variance associated with SRV *H. B. Bigelow* conversion factors.

YEAR	Mean number per tow	CV	Mean kg per tow	CV
1975	0.05	100.0	0.010	100.0
1976	0.07	14.4	0.002	88.1
1977	0.64	97.1	0.144	96.6
1978	0.28	42.6	0.049	48.1
1979	0.03	45.5	0.007	50.1
1980	1.00	99.9	0.042	99.7
1981	0.02	49.7	0.006	39.7
1982	0.00	100.0	0.000	100.0
1983	0.05	71.0	0.014	71.0
1984	0.05	18.5	0.006	34.0
1985	0.08	75.4	0.012	86.1
1986	0.03	46.7	0.005	54.4
1987	0.02	56.8	0.004	52.7
1988	0.00		0.000	
1989	0.02	70.7	0.004	70.7
1990	0.00		0.000	
1991	0.09	70.7	0.011	88.7
1992	0.00		0.000	
1993	0.05	75.3	0.003	56.0
1994	0.52	4.6	0.027	8.9
1995	0.25	2.6	0.029	2.3
1996	0.04	0.0	0.001	0.0
1997	0.16	54.4	0.019	56.9
1998	0.00		0.000	
1999	0.01	25.4	0.002	31.1
2000	0.20	35.1	0.028	29.9
2001	0.05	9.7	0.004	12.7
2002	0.59	58.5	0.090	61.5
2003	0.31	25.7	0.046	22.9
2004	0.65	5.8	0.031	16.1
2005	0.48	2.5	0.028	3.5
2006	0.08	58.6	0.011	69.4
2007	0.10	28.4	0.008	33.9

2008	0.36	10.6	0.040	12.8
2009	2.30	58.5	0.066	61.4
2010	1.59	18.0	0.081	20.7

Table 4. Stratified mean number per tow and mean weight (kg) per tow indices for blueback herring caught during daytime tows (between sunrise and sunset) in NEFSC spring bottom trawl surveys, 1976-2010. CVs for indices from 2009 onward do not account for the additional variance associated with SRV *H. B. Bigelow* conversion factors.

YEAR	Mean number per tow	CV	Mean kg per tow	CV
1976	2.64	31.1	0.141	26.6
1977	1.03	27.6	0.111	29.5
1978	2.76	19.6	0.297	31.5
1979	11.79	23.3	1.522	43.4
1980	4.64	48.8	0.266	30.1
1981	5.69	34.6	0.377	46.4
1982	1.25	19.8	0.087	33.7
1983	1.60	21.2	0.153	26.9
1984	9.47	52.6	0.946	55.4
1985	2.22	29.6	0.282	42.2
1986	2.53	12.2	0.075	28.6
1987	2.25	11.8	0.230	10.1
1988	1.12	21.6	0.060	24.7
1989	0.96	26.7	0.060	30.4
1990	0.79	22.2	0.052	28.3
1991	0.58	18.5	0.032	45.2
1992	2.99	49.1	0.310	73.6
1993	5.37	15.1	0.195	21.0
1994	2.20	23.1	0.127	36.0
1995	4.19	16.8	0.285	5.5
1996	2.41	16.2	0.155	24.5
1997	1.85	16.2	0.151	18.0
1998	0.91	28.6	0.026	31.7
1999	2.19	21.6	0.162	23.7
2000	1.35	34.0	0.142	52.0
2001	0.77	23.7	0.055	22.3
2002	0.71	14.8	0.070	19.8
2003	2.55	17.6	0.133	12.8
2004	2.80	23.9	0.133	38.8
2005	0.76	18.9	0.029	22.0
2006	7.11	25.2	0.178	36.8
2007	6.07	29.2	0.390	28.0
2008	2.24	28.9	0.100	36.8
2009	13.95	64.5	0.656	76.5
2010	3.26	30.3	0.129	40.5
2011	2.83	22.6	0.109	29.8

Table 5. Stratified mean number per tow and mean weight (kg) per tow indices for alewife caught during daytime tows (between sunrise and sunset) in NEFSC fall bottom trawl surveys, 1975-2010. CVs for indices from 2009 onward do not account for the additional variance associated with SRV *H. B. Bigelow* conversion factors.

YEAR	Mean number per tow	CV	Mean kg per tow	CV
1975	1.00	33.6	0.20	29.2
1976	2.38	5.6	0.31	6.3
1977	0.75	39.2	0.09	36.4
1978	0.85	24.0	0.10	20.3
1979	0.80	43.4	0.14	38.2
1980	6.41	67.5	0.45	60.1
1981	2.32	44.4	0.25	14.9
1982	0.72	6.2	0.08	15.3
1983	0.38	29.3	0.07	33.8
1984	0.87	70.3	0.07	50.9
1985	2.36	67.4	0.36	78.9
1986	0.98	18.9	0.19	20.1
1987	1.43	27.3	0.30	24.3
1988	1.59	18.3	0.18	11.6
1989	1.77	37.5	0.13	21.8
1990	1.11	26.0	0.09	40.1
1991	1.65	5.2	0.09	11.5
1992	1.08	22.3	0.13	33.4
1993	1.19	23.0	0.06	13.7
1994	3.45	41.0	0.43	35.9
1995	4.30	10.4	0.58	14.1
1996	0.64	32.2	0.08	43.0
1997	0.93	18.8	0.10	22.6
1998	4.81	32.9	0.41	30.7
1999	1.20	33.4	0.14	34.2
2000	4.55	19.5	0.56	15.9
2001	0.47	20.6	0.06	14.2
2002	5.71	37.8	0.96	48.2
2003	2.04	21.4	0.33	12.3
2004	2.76	34.9	0.25	23.1
2005	5.04	15.6	0.46	23.3
2006	5.36	42.4	0.63	37.4
2007	2.50	14.8	0.35	12.9
2008	7.32	18.0	1.04	23.3
2009	6.37	14.6	0.72	14.9
2010	10.85	24.4	1.82	20.6

Table 6. Stratified mean number per tow and mean weight (kg) per tow indices for alewife caught during daytime tows (between sunrise and sunset) in NEFSC spring bottom trawl surveys, 1976-2010. CVs for indices from 2009 onward do not account for the additional variance associated with SRV *H. B. Bigelow* conversion factors.

YEAR	Mean number per tow	CV	Mean kg per tow	CV
1976	6.72	34.6	0.91	40.7
1977	5.44	30.1	0.96	31.9
1978	8.30	14.8	0.95	10.7
1979	12.64	41.9	1.44	43.5
1980	15.18	29.9	1.19	30.0
1981	8.99	28.3	1.00	27.4
1982	7.05	22.7	0.69	23.4
1983	3.28	30.8	0.64	44.1
1984	5.03	36.8	0.89	45.7
1985	2.52	20.1	0.39	24.2
1986	4.04	26.8	0.60	21.9
1987	7.93	9.7	1.30	9.1
1988	2.96	14.6	0.40	16.0
1989	4.08	18.8	0.35	21.1
1990	5.00	14.3	0.33	16.2
1991	6.24	34.9	0.48	51.5
1992	13.86	6.8	2.10	5.5
1993	10.33	18.3	0.76	16.8
1994	6.96	24.4	0.32	20.5
1995	6.95	26.9	0.99	29.4
1996	14.87	33.8	1.55	33.7
1997	11.85	25.4	1.60	29.3
1998	11.93	17.8	1.22	19.9
1999	14.65	24.3	1.51	26.5
2000	12.45	51.3	0.83	18.3
2001	5.99	24.8	0.71	33.4
2002	7.35	10.2	0.97	13.8
2003	8.57	22.9	0.59	25.7
2004	10.95	23.7	0.85	35.8
2005	4.72	15.8	0.27	24.7
2006	16.88	21.7	0.66	21.9
2007	5.87	17.9	0.56	17.4
2008	8.51	24.4	0.61	22.2
2009	15.94	14.6	1.57	12.4
2010	14.61	11.5	1.41	11.8
2011	37.72	16.2	2.51	21.3

Table 7. Stratified mean number per tow and mean weight (kg) per tow indices for American shad caught during daytime tows (between sunrise and sunset) in NEFSC fall bottom trawl surveys, 1975-2010. CVs for indices from 2009 onward do not account for the additional variance associated with SRV *H. B. Bigelow* conversion factors.

YEAR	Mean number per tow	CV	Mean kg per tow	CV
1975	0.01	49.2	0.01	61.6
1976	0.24	26.0	0.06	21.2
1977	0.03	79.9	0.02	66.9
1978	0.31	56.9	0.08	40.3
1979	0.08	38.9	0.04	32.4
1980	0.15	70.6	0.03	53.0
1981	0.59	40.6	0.12	30.6
1982	1.14	4.6	0.26	17.3
1983	0.66	94.8	0.13	91.0
1984	0.04	44.8	0.01	39.7
1985	0.11	30.8	0.02	32.5
1986	0.05	31.9	0.02	44.1
1987	1.17	8.4	0.37	20.9
1988	0.07	44.8	0.01	33.8
1989	0.11	25.7	0.03	35.5
1990	0.12	27.6	0.07	83.3
1991	0.05	46.9	0.02	60.8
1992	4.21	86.8	0.57	73.9
1993	0.08	47.8	0.02	43.5
1994	0.96	51.8	0.15	51.1
1995	0.65	51.7	0.60	67.3
1996	0.28	51.4	0.08	38.3
1997	0.19	40.9	0.09	49.1
1998	0.22	23.1	0.10	32.1
1999	0.16	57.9	0.03	59.8
2000	0.27	30.6	0.07	33.9
2001	0.07	18.9	0.03	21.7
2002	0.20	33.9	0.13	42.0
2003	0.21	38.0	0.08	14.9
2004	0.16	28.7	0.06	30.7
2005	0.16	54.6	0.07	81.7
2006	0.23	27.1	0.04	25.5
2007	0.17	25.5	0.04	28.1
2008	0.59	51.6	0.28	78.1
2009	0.10	32.5	0.03	35.2
2010	0.28	20.2	0.11	34.8

Table 8. Stratified mean number per tow and mean weight (kg) per tow indices for American shad caught during daytime tows (between sunrise and sunset) in NEFSC spring bottom trawl surveys, 1976-2010. CVs for indices from 2009 onward do not account for the additional variance associated with SRV *H. B. Bigelow* conversion factors.

YEAR	Mean number per tow	CV	Mean kg per tow	CV
1976	0.22	38.2	0.05	45.2
1977	0.04	58.3	0.00	55.0
1978	0.15	20.8	0.07	16.1
1979	0.52	32.2	0.12	33.7
1980	0.25	15.8	0.07	26.6
1981	0.40	37.6	0.09	32.1
1982	0.25	30.2	0.05	30.3
1983	0.18	25.4	0.07	59.1
1984	0.34	27.1	0.09	30.8
1985	0.35	18.8	0.18	40.0
1986	0.33	48.4	0.24	64.5
1987	0.15	27.6	0.07	34.3
1988	0.16	28.0	0.09	23.4
1989	0.32	21.2	0.09	32.3
1990	0.37	39.0	0.11	51.9
1991	0.58	28.1	0.16	27.6
1992	0.49	17.8	0.10	15.4
1993	0.57	10.6	0.13	22.6
1994	1.16	69.6	0.49	82.1
1995	0.32	13.2	0.09	37.9
1996	0.43	14.3	0.07	17.7
1997	0.56	15.9	0.23	18.0
1998	0.28	26.0	0.10	22.9
1999	0.36	14.2	0.17	29.5
2000	0.37	18.7	0.13	26.9
2001	0.36	34.6	0.16	35.7
2002	0.33	19.6	0.11	23.9
2003	0.28	22.5	0.05	24.9
2004	0.24	33.6	0.06	40.5
2005	0.13	32.8	0.06	74.1
2006	0.61	12.7	0.03	15.0
2007	0.59	28.7	0.11	36.5
2008	0.38	25.1	0.10	33.3
2009	0.47	18.1	0.13	25.7
2010	0.28	25.6	0.07	24.2
2011	0.59	32.9	0.13	27.1

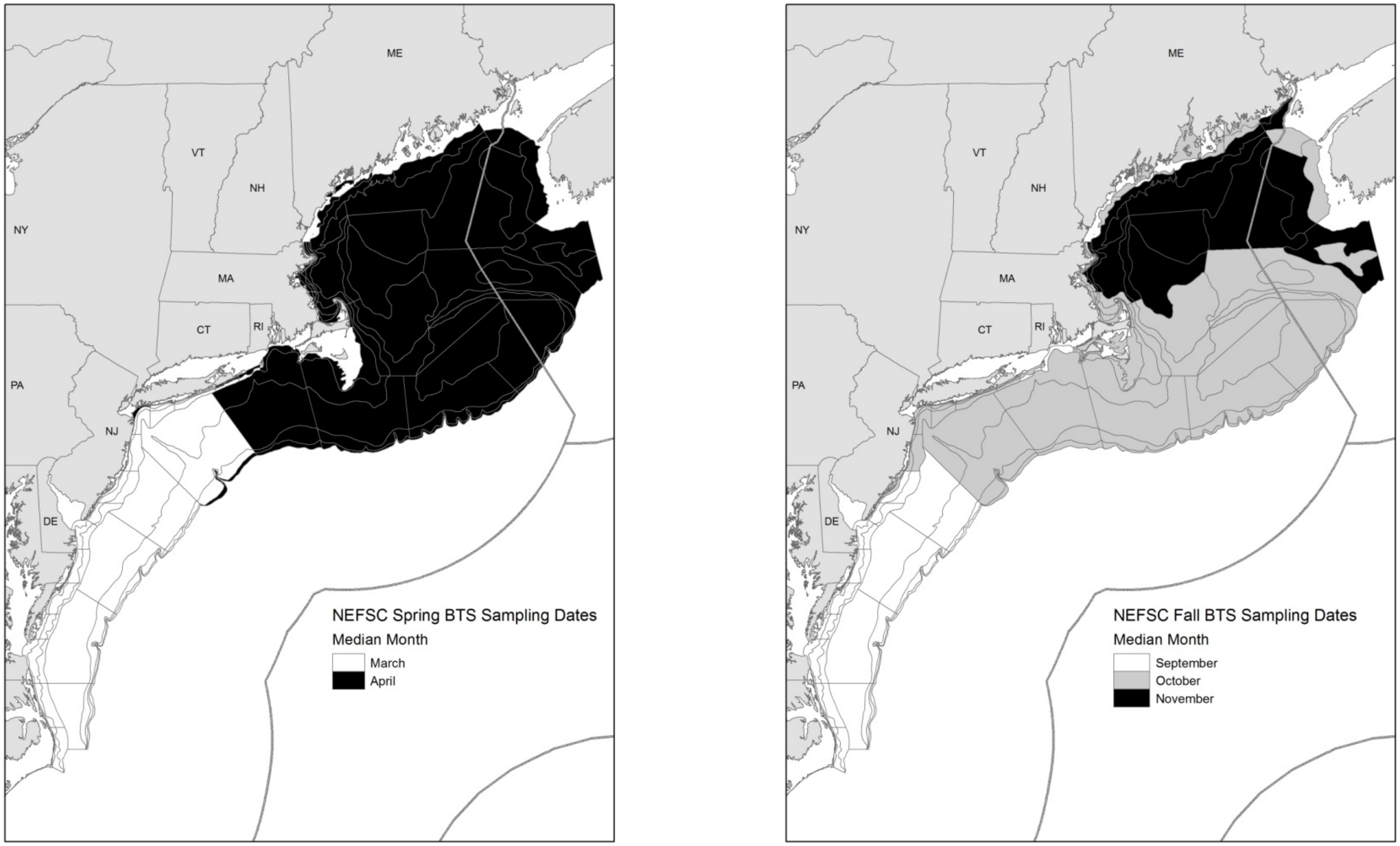


Figure 1. Median month during which the inshore and offshore depth strata were sampled during Northeast Fisheries Science Center spring and fall bottom trawl surveys, 1976-2010.

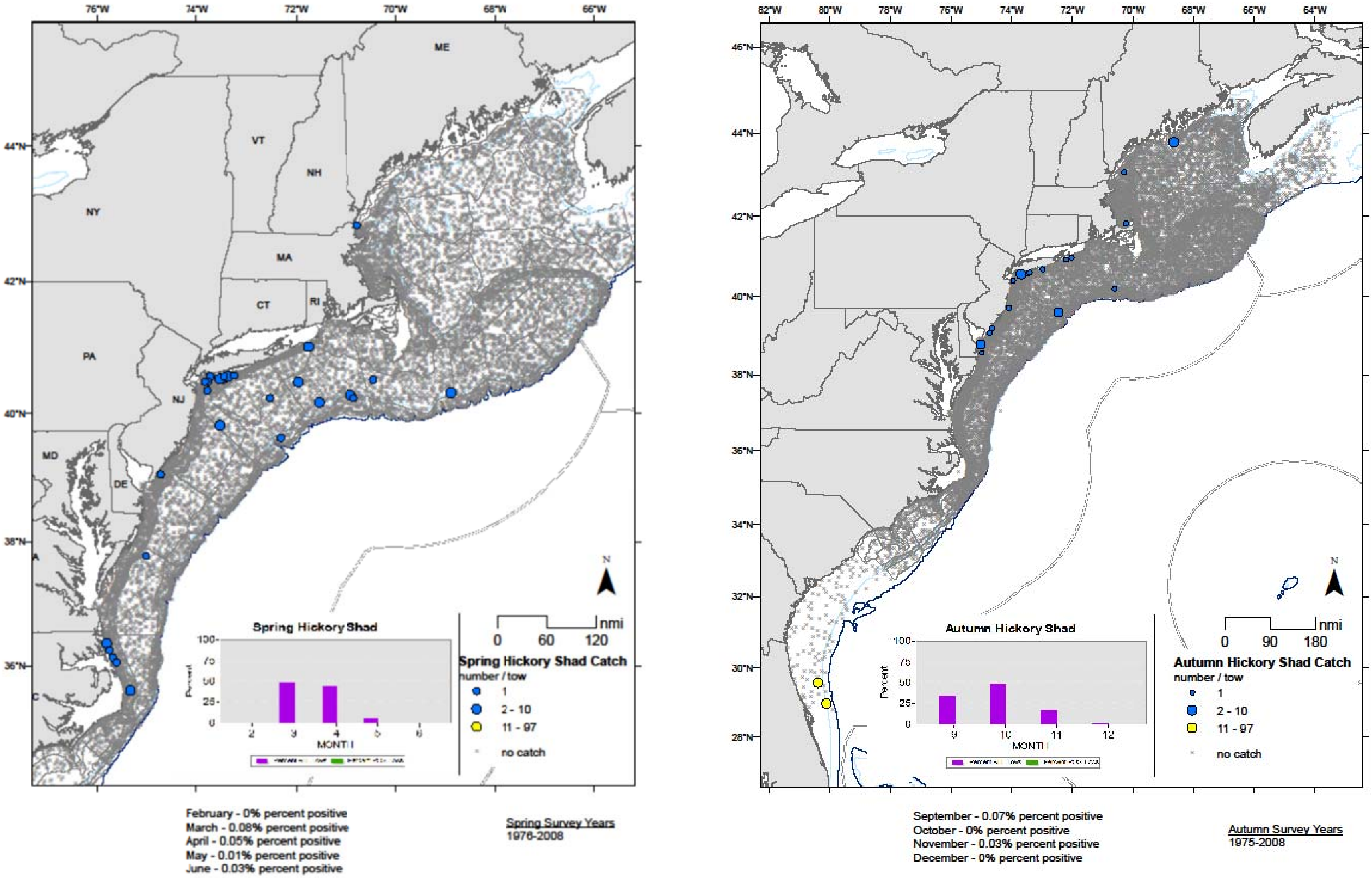


Figure 2. Distribution of hickory shad during NEFSC spring (1976-2008, left panel) and fall (1985-2008, right panel) bottom trawls surveys.

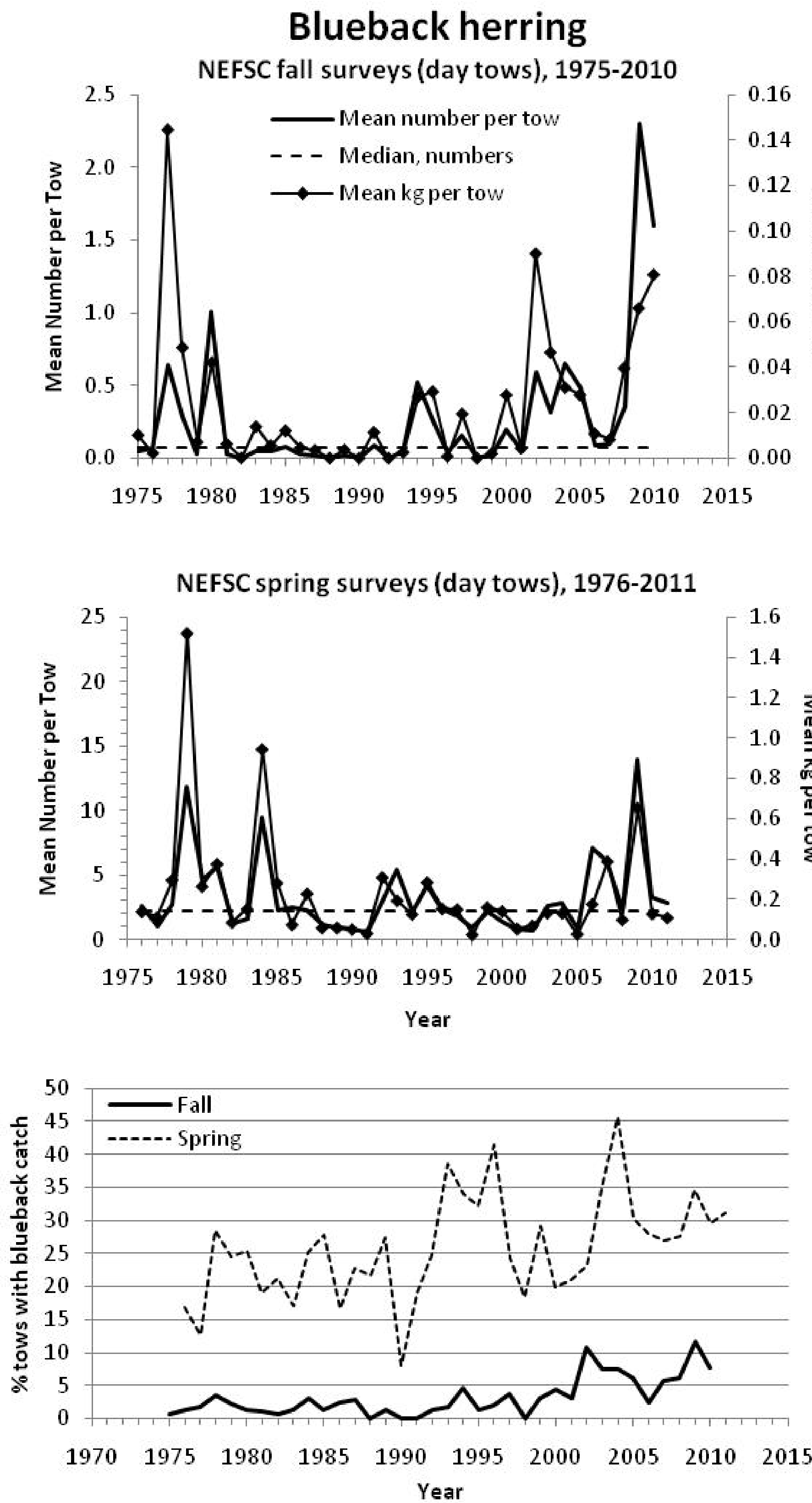


Figure 3. Blueback herring relative abundance (mean number per tow) and biomass (mean kg per tow) indices and percent positive tows for NEFSC fall (1975-2010) and spring (1976-2011) bottom trawl surveys.

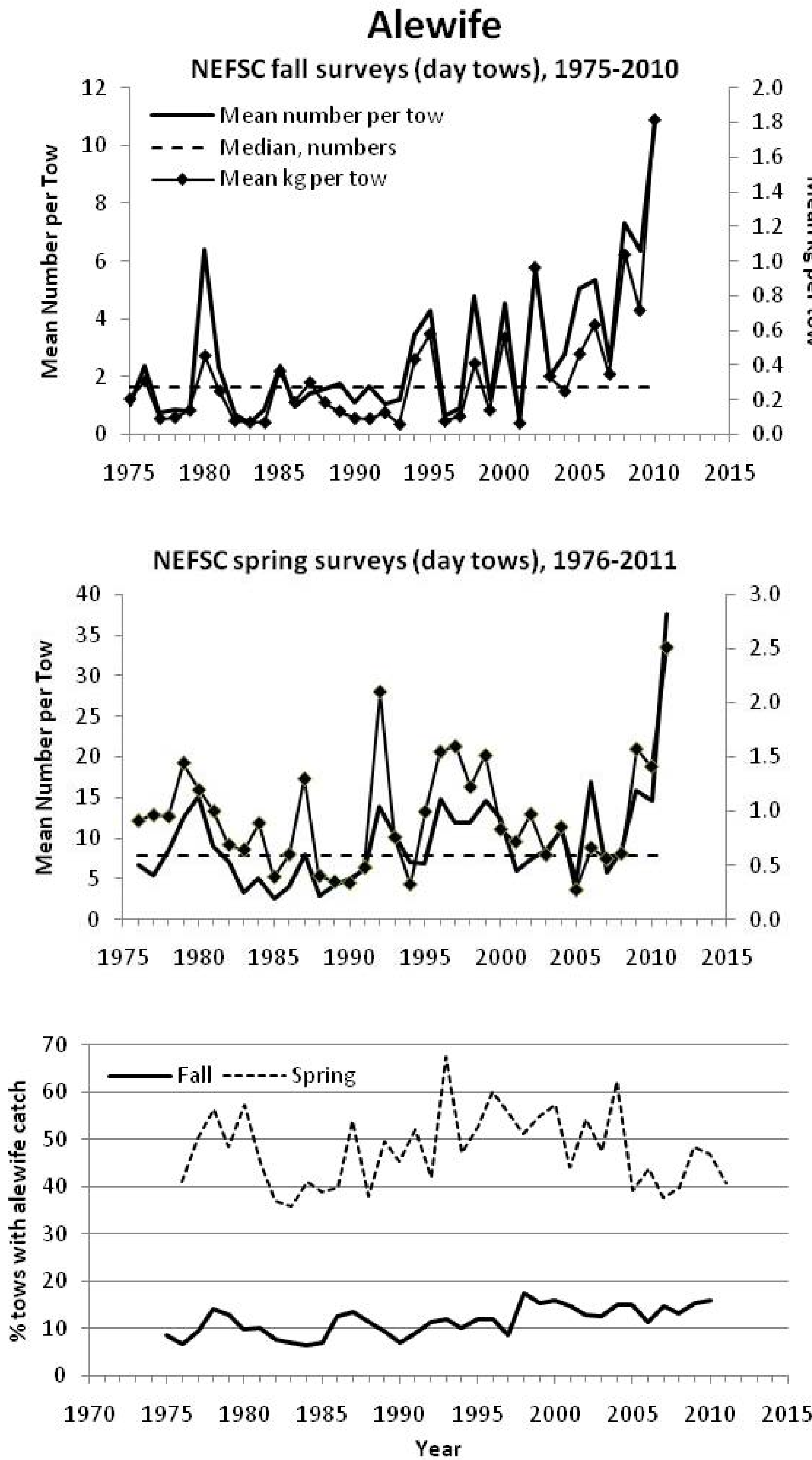


Figure 4. Alewife relative abundance (mean number per tow) and biomass (mean kg per tow) indices and percent positive tows for NEFSC fall (1975-2010) and spring (1976-2011) bottom trawl surveys.

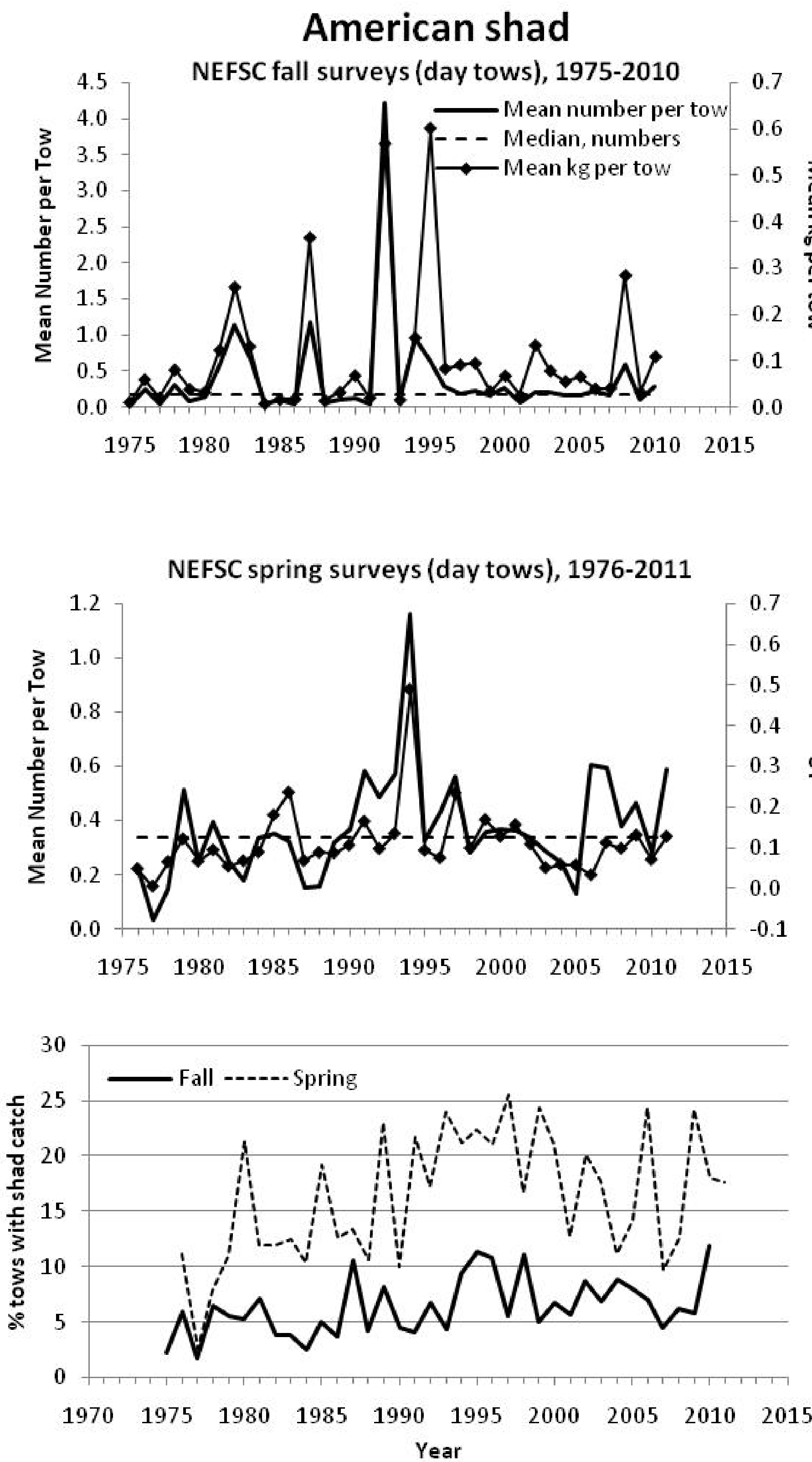
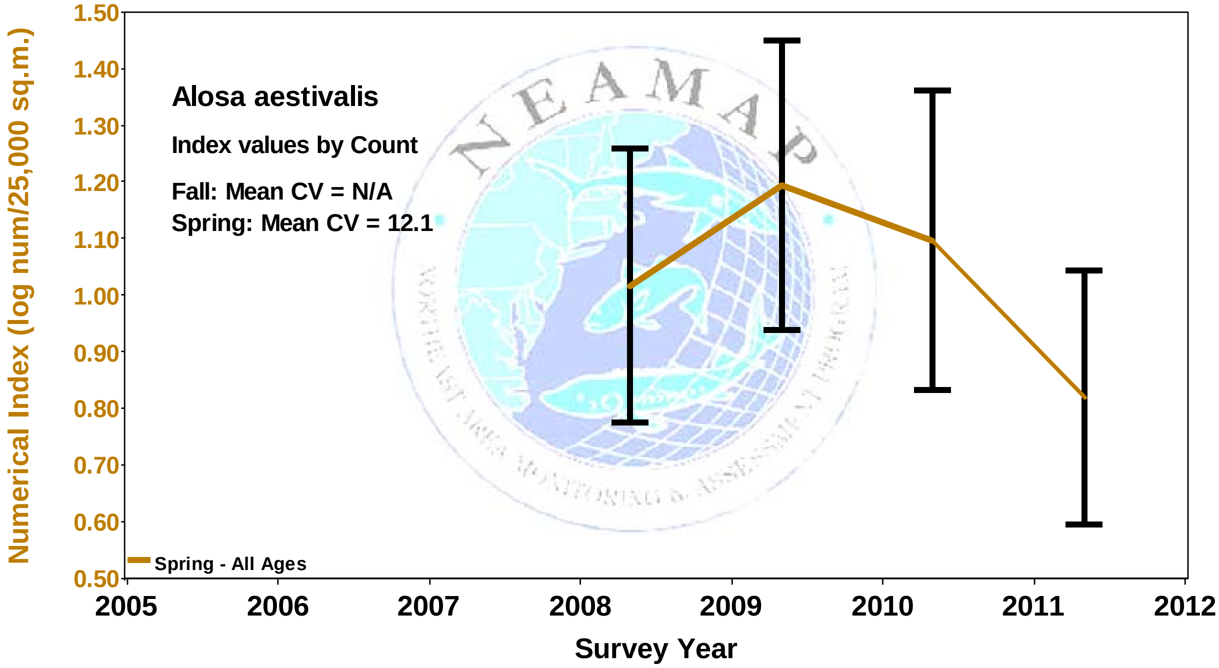


Figure 5. American shad relative abundance (mean number per tow) and biomass (mean kg per tow) indices and percent positive tows for NEFSC fall (1975-2010) and spring (1976-2011) bottom trawl surveys.



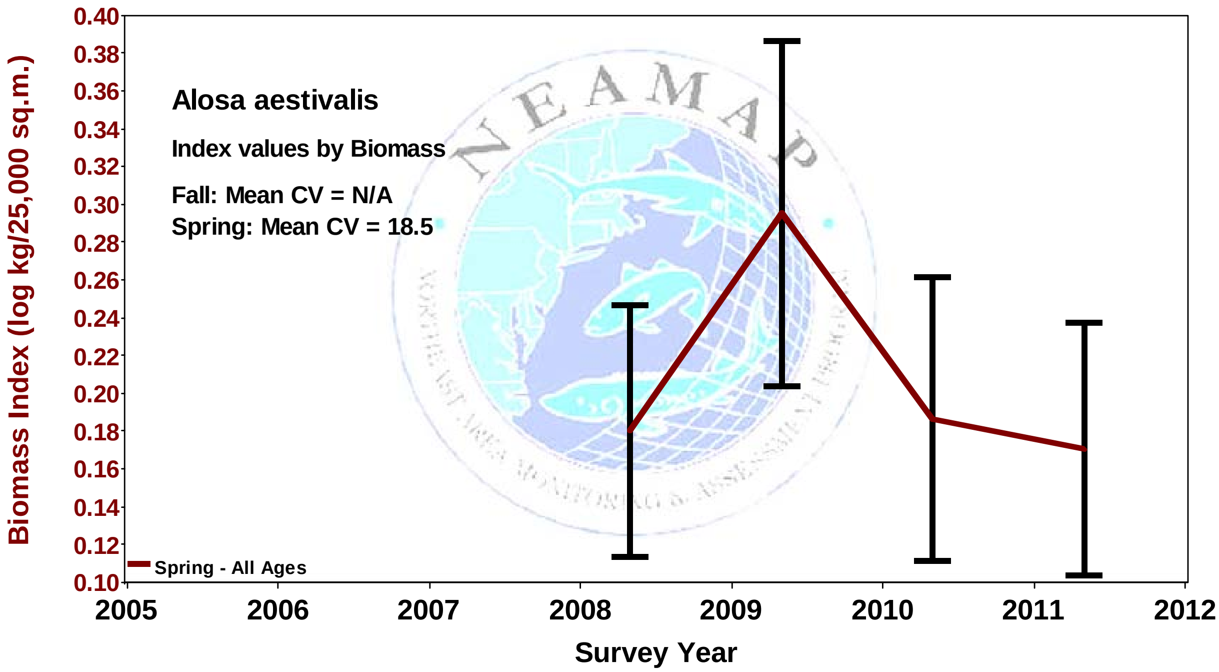
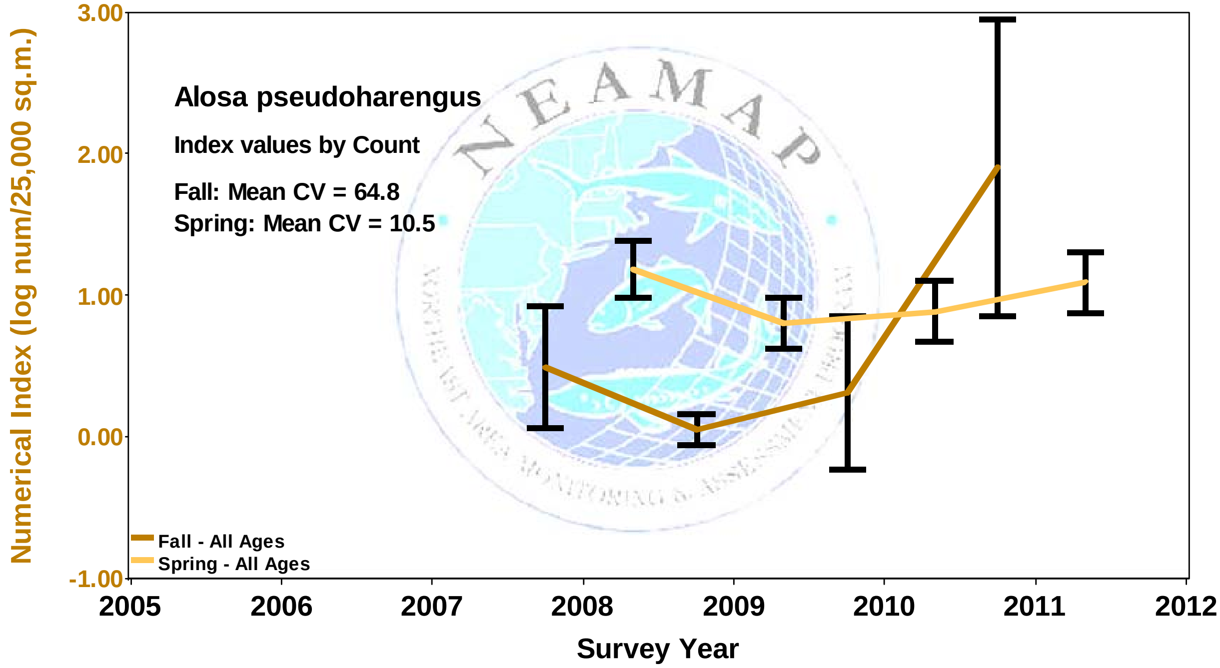


Figure 6. Swept area abundance (log number per 25,000 m^2) and biomass (log kg per 25,000 m^2) estimates of blueback herring derived from the spring (2008-2011) NEAMAP bottom trawl surveys.



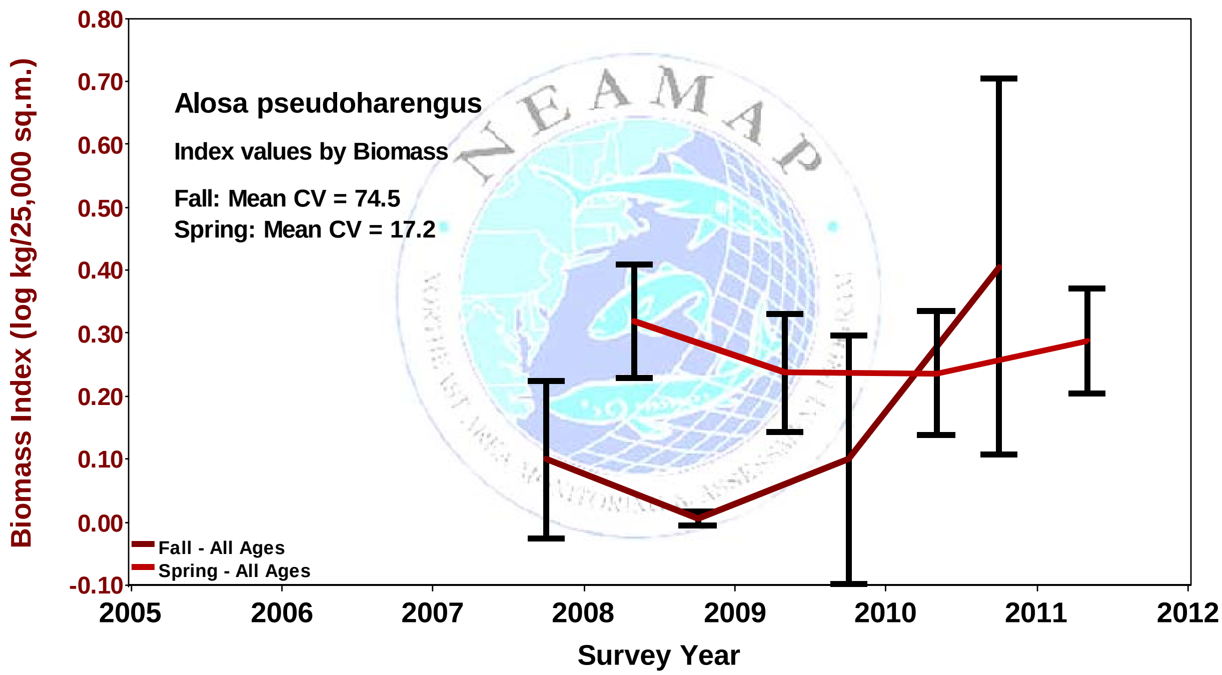


Figure 7. Swept area abundance (log number per 25,000 m^2) and biomass (log kg per 25,000 m^2) estimates of alewife derived from the fall (2007-2010) and spring (2008-2011) NEAMAP bottom trawl surveys.

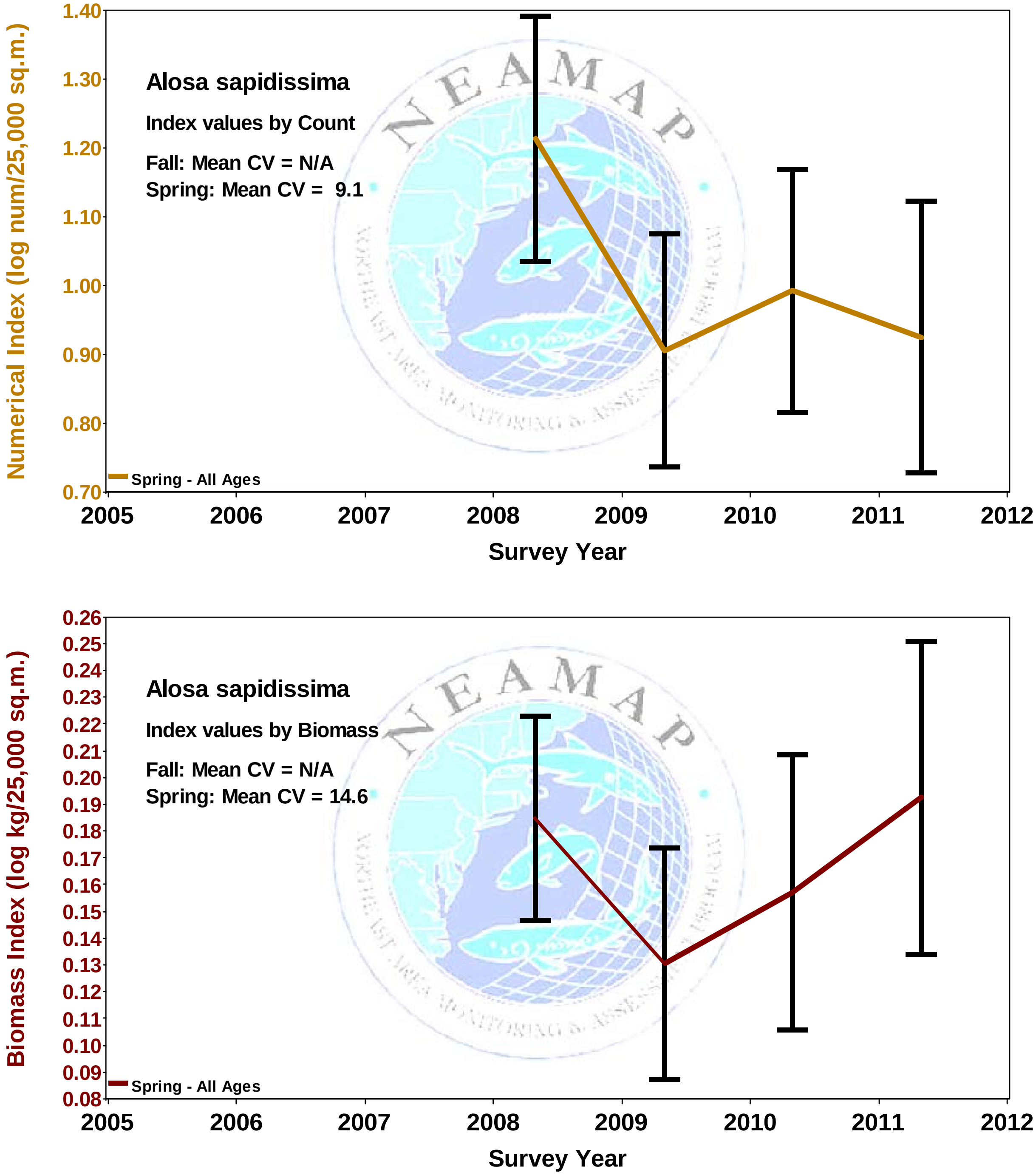


Figure 8. Swept area abundance (log number per 25,000 m^2) and biomass (log kg per 25,000 m^2) estimates of American shad derived from the spring (2008-2011) NEAMAP bottom trawl surveys.

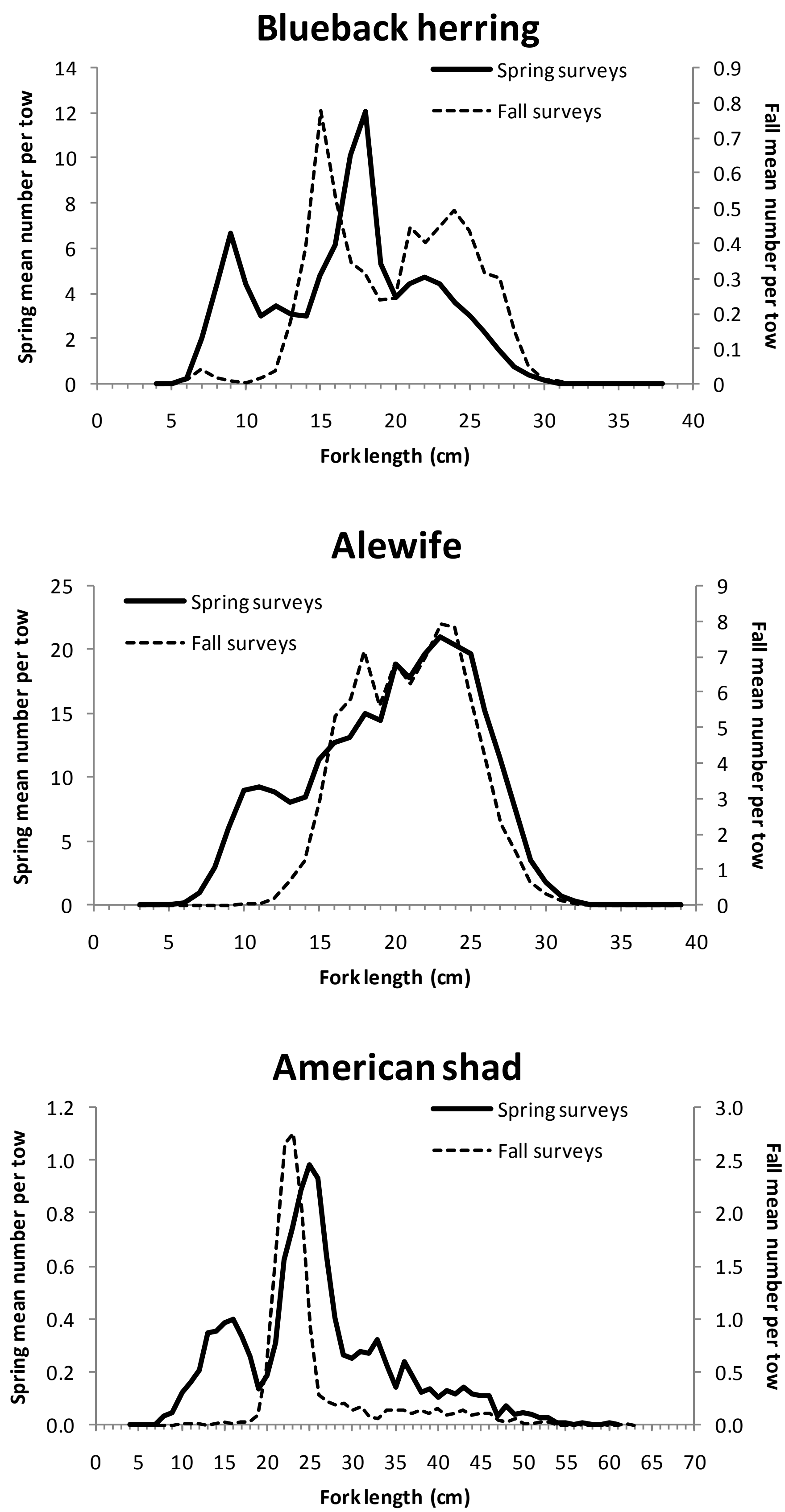


Figure 9. Length compositions (stratified mean numbers per tow) of blueback herring, alewife, and American shad caught during NEFSC spring and fall bottom trawl surveys, 1976-2008.

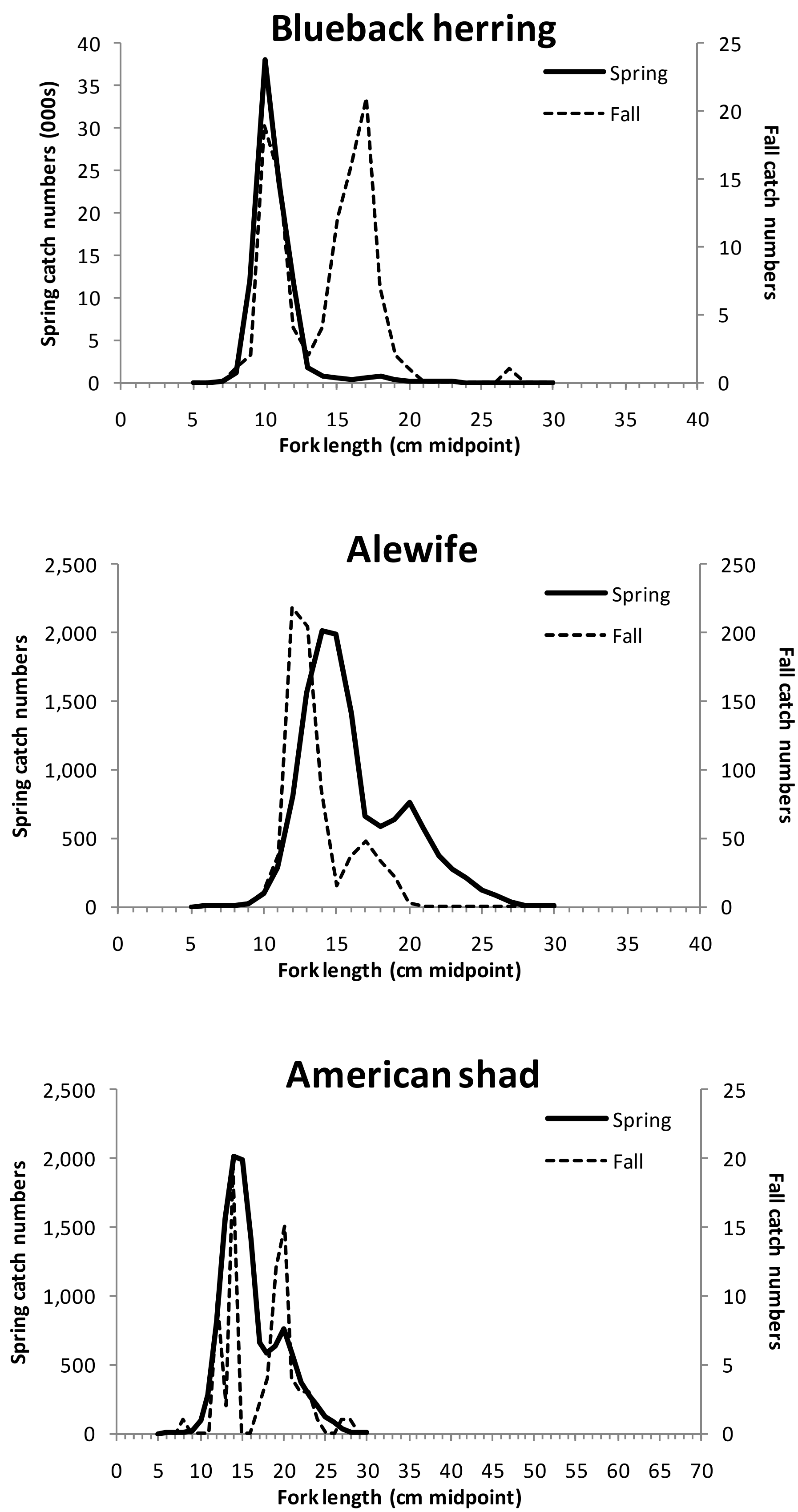


Figure 10. Length compositions (stratified mean numbers per tow) of blueback herring, alewife, and American shad caught during NEAMAP spring (2008-2011) and fall (2007-2010) bottom trawl surveys

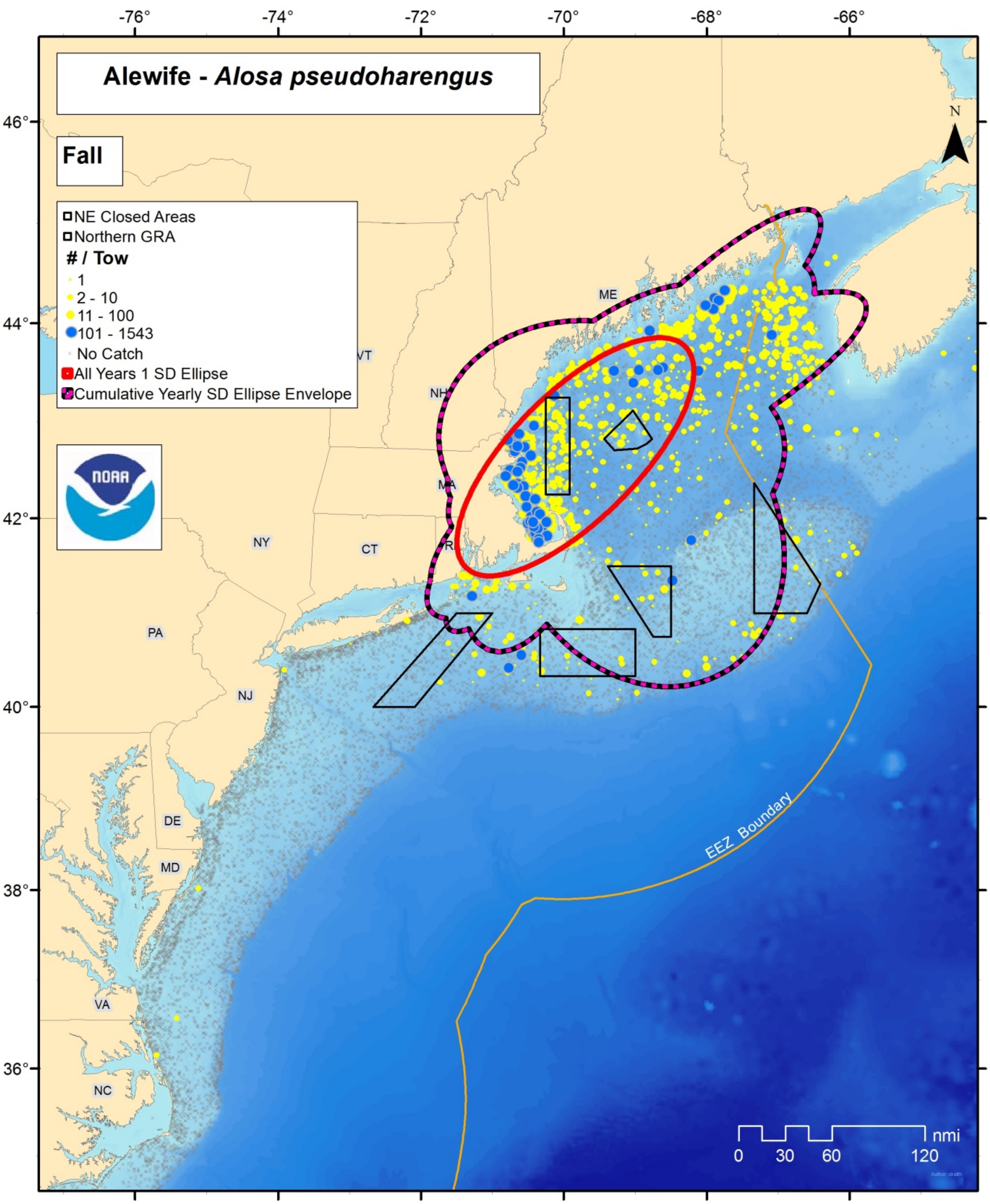


Figure 11. The standard deviational ellipse (one standard deviation) for *Alosa pseudoharengus* catches (numbers per tow) in fall NEFSC and NEAMAP bottom trawl surveys, for all years combined during 1975-2010 (red ellipse), and the "envelope" which encompasses all of the annual standard deviational ellipses for the same time period.

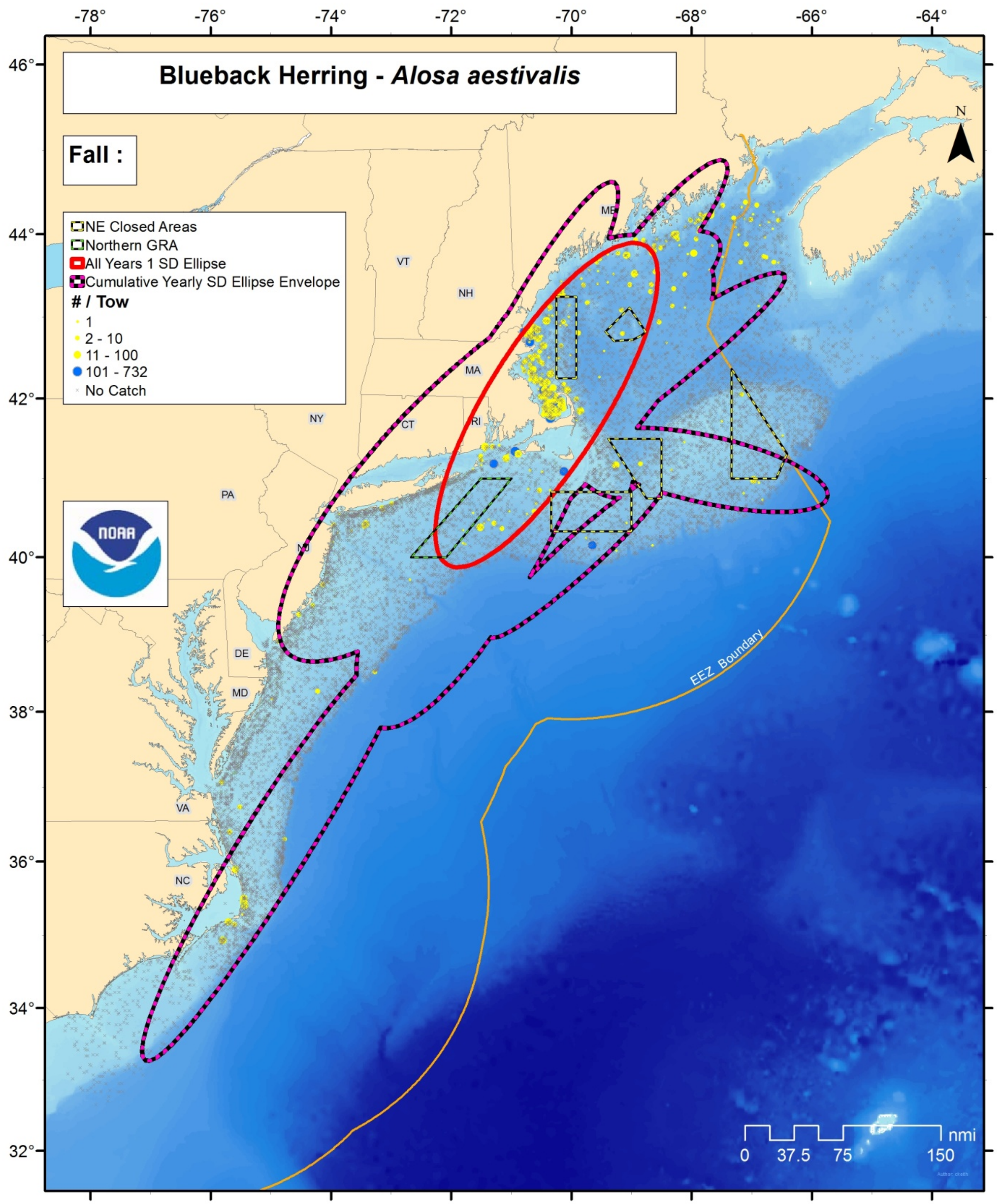


Figure 12. The standard deviational ellipse (one standard deviation) for *Alosa aestivalis* catches (numbers per tow) in fall NEFSC and NEAMAP bottom trawl surveys, for all years combined during 1975-2010 (red ellipse), and the "envelope" which encompasses all of the annual standard deviational ellipses for the same time period.

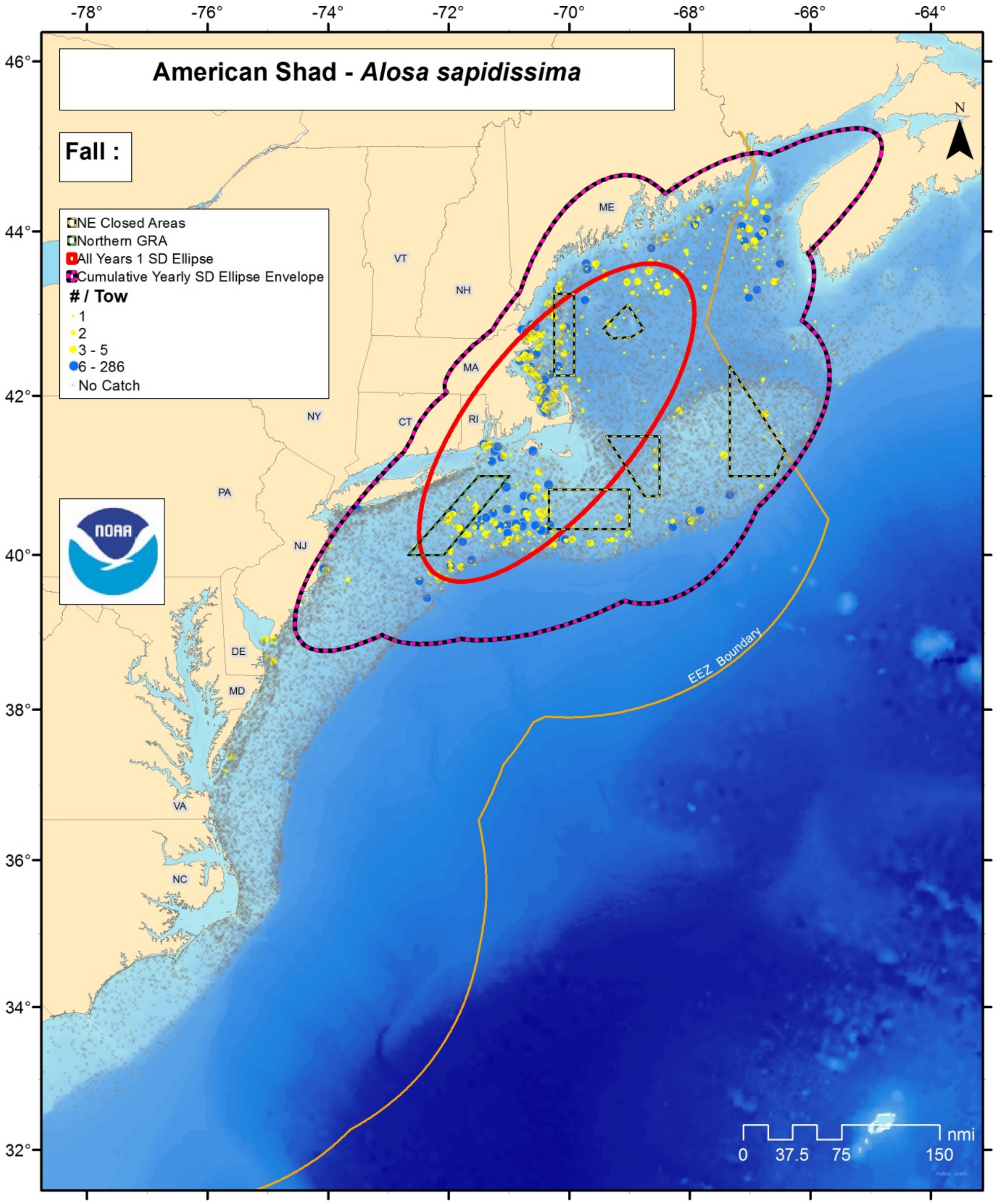


Figure 13. The standard deviational ellipse (one standard deviation) for *Alosa sapidissima* catches (numbers per tow) in fall NEFSC and NEAMAP bottom trawl surveys, for all years combined during 1975-2010 (red ellipse), and the "envelope" which encompasses all of the annual standard deviational ellipses for the same time period.

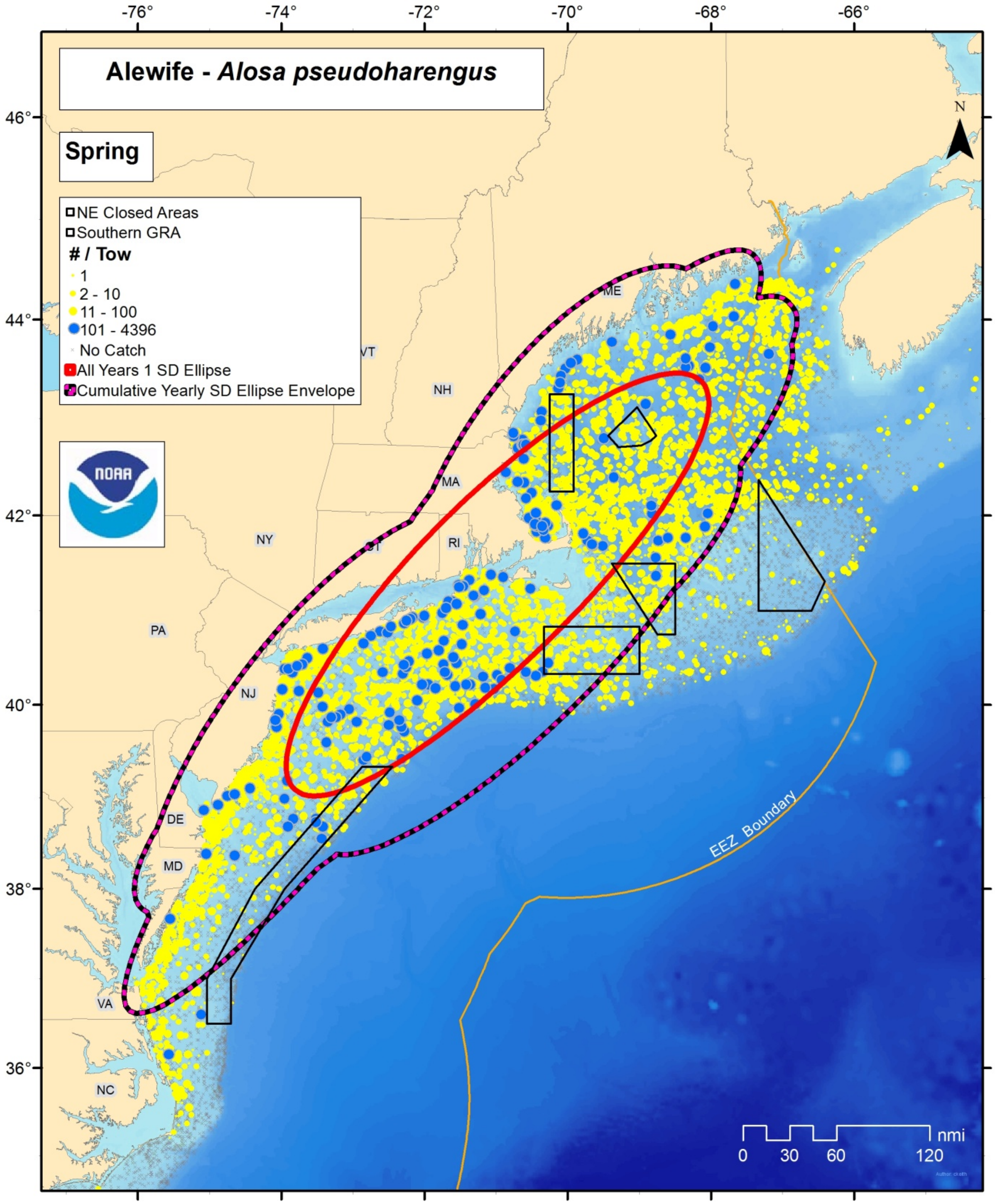


Figure 14. The standard deviational ellipse (one standard deviation) for *Alosa pseudoharengus* catches (numbers per tow) in spring NEFSC and NEAMAP bottom trawl surveys, for all years combined during 1976-2010 (red ellipse), and the “envelope” which encompasses all of the annual standard deviational ellipses for the same time period.

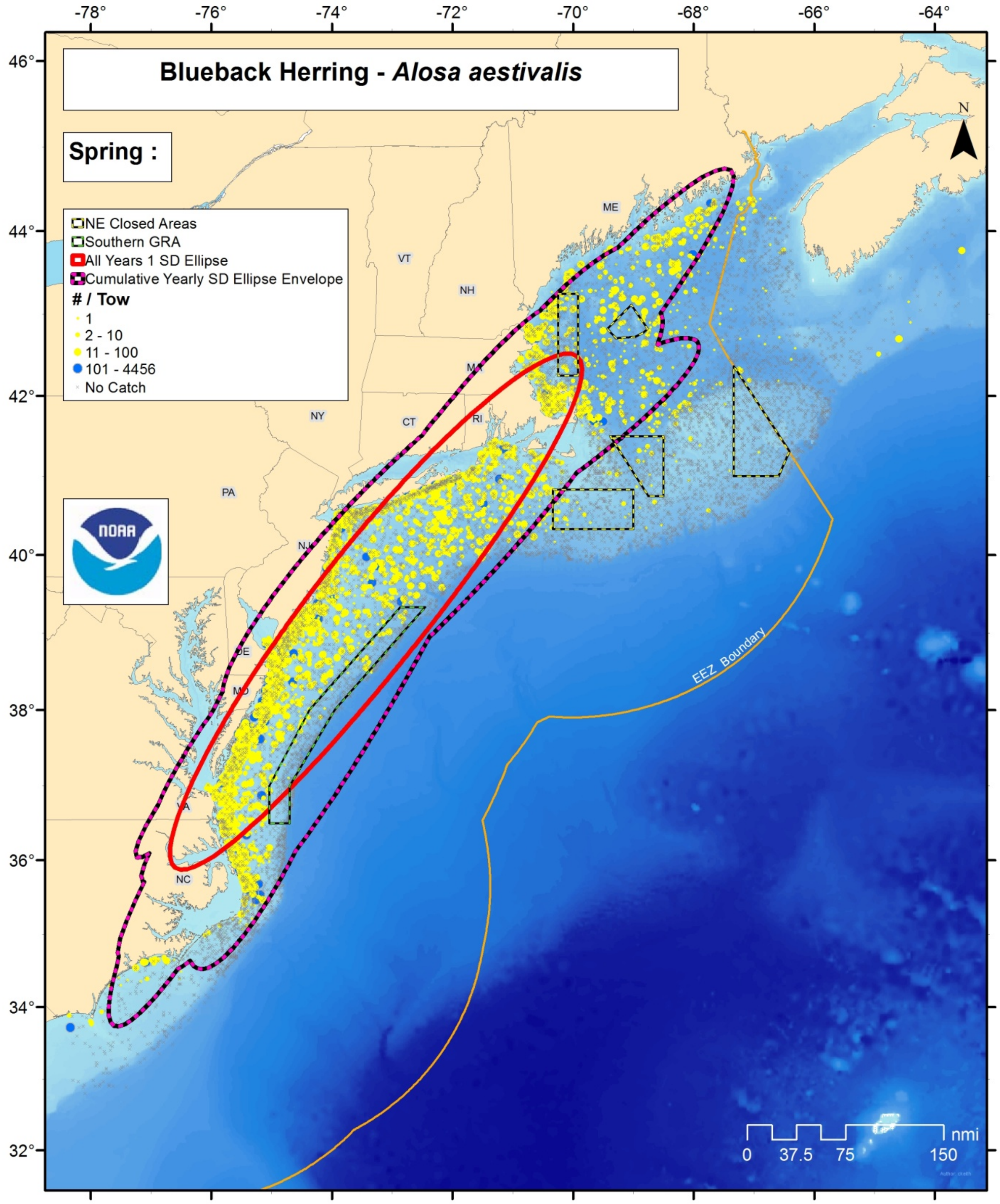


Figure 15. The standard deviational ellipse (one standard deviation) for *Alosa aestivalis* catches (numbers per tow) in spring NEFSC and NEAMAP bottom trawl surveys, for all years combined during 1976-2010 (red ellipse), and the "envelope" which encompasses all of the annual standard deviational ellipses for the same time period.

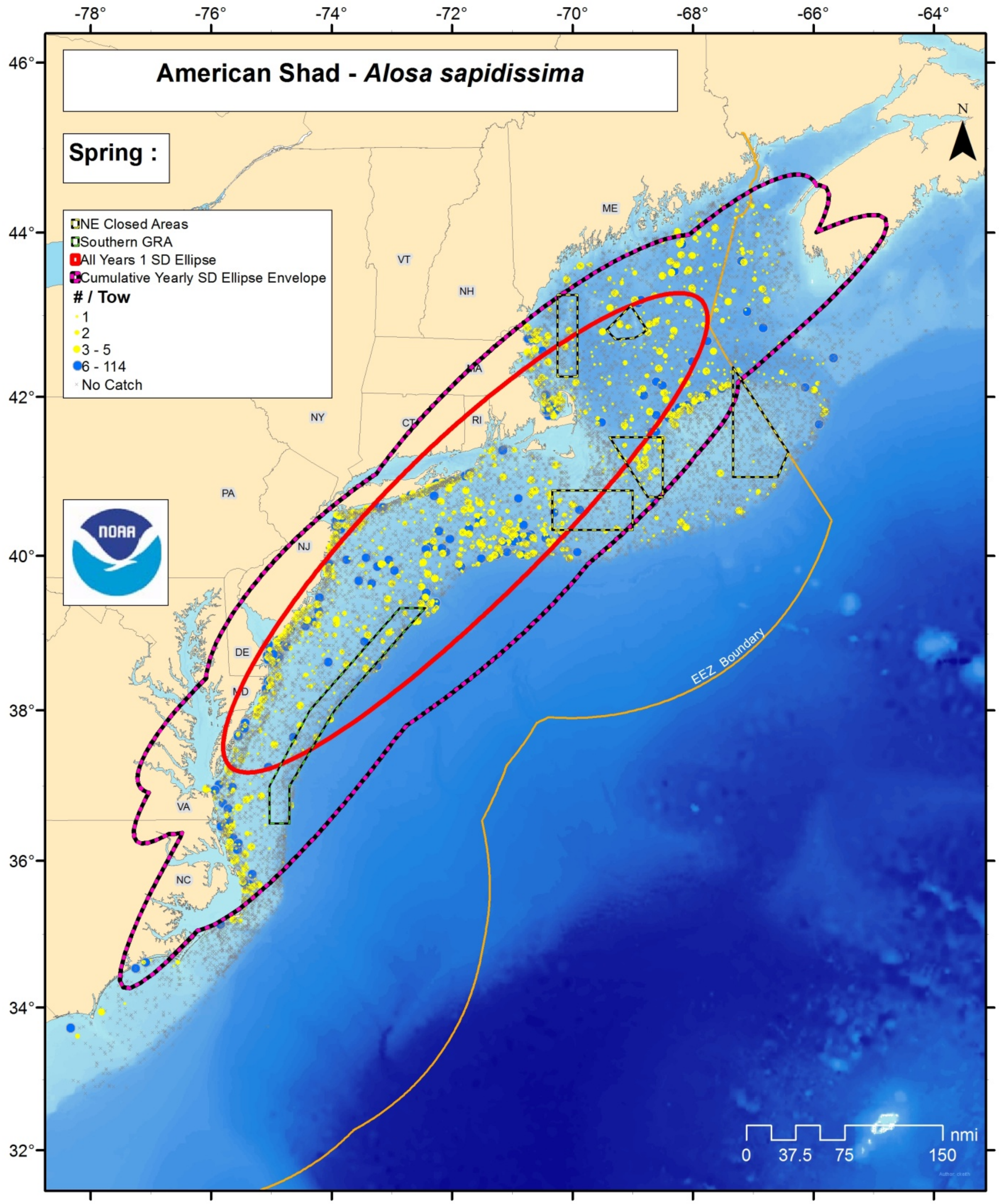


Figure 16. The standard deviational ellipse (one standard deviation) for *Alosa sapidissima* catches (numbers per tow) in spring NEFSC and NEAMAP bottom trawl surveys, for all years combined during 1976-2010 (red ellipse), and the “envelope” which encompasses all of the annual ellipses for the same time period.

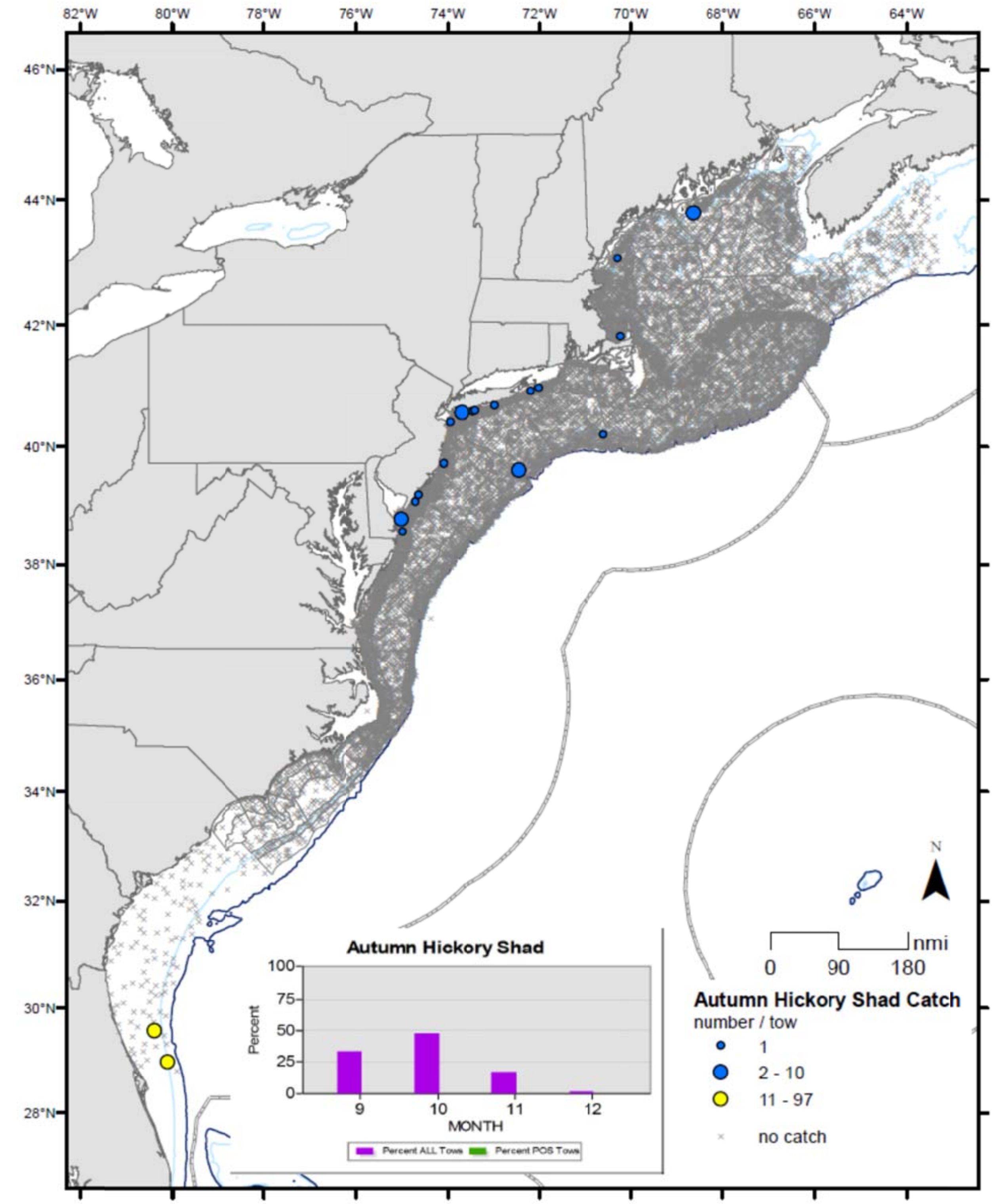


Figure 17. Distribution of *Alosa mediocris* (numbers per tow) during NEFSC and NEAMAP fall surveys, 1975-2010.

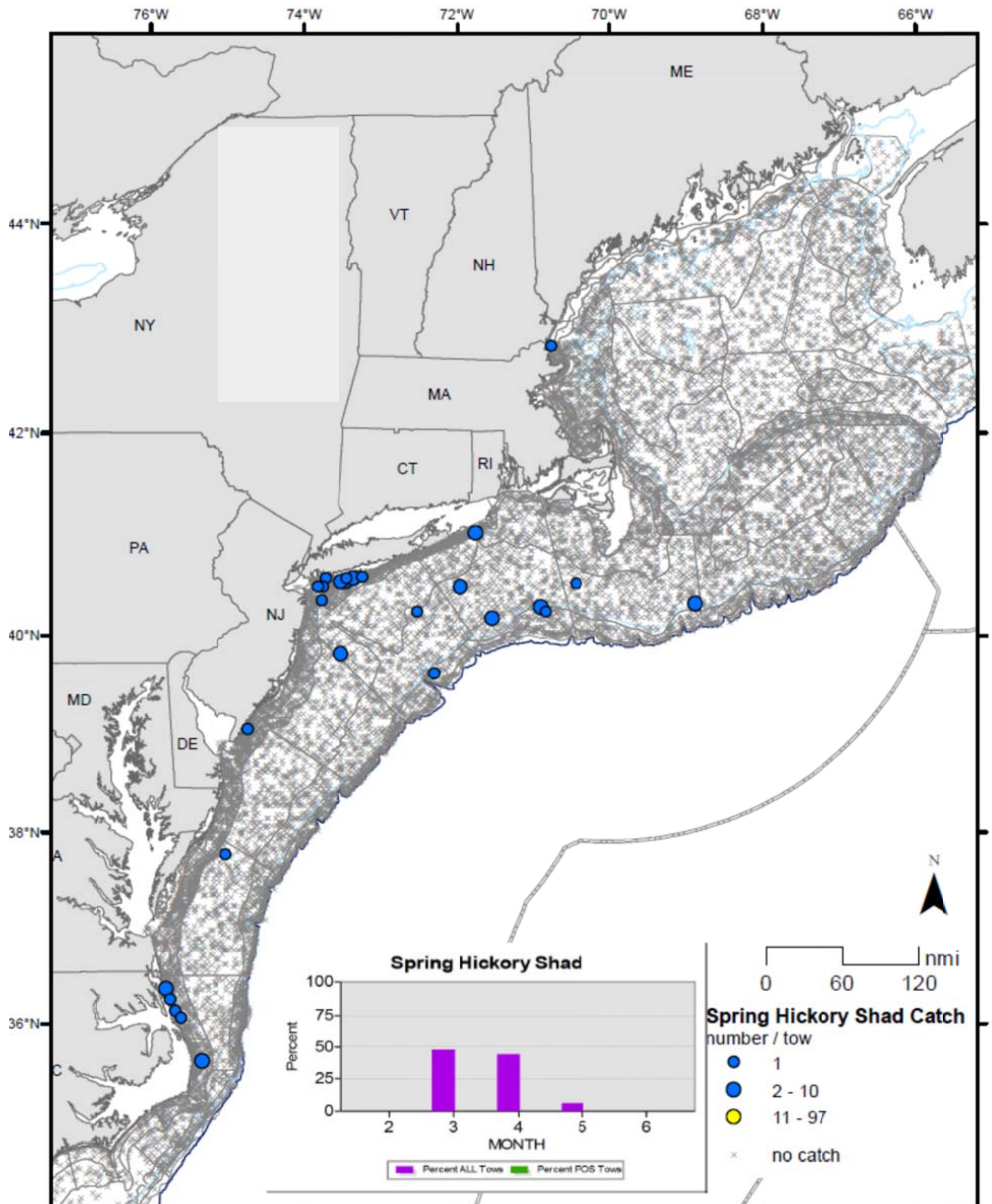


Figure 18. Distribution of *Alosa mediocris* (numbers per tow) during NEFSC and NEAMAP spring surveys, 1976-2010.

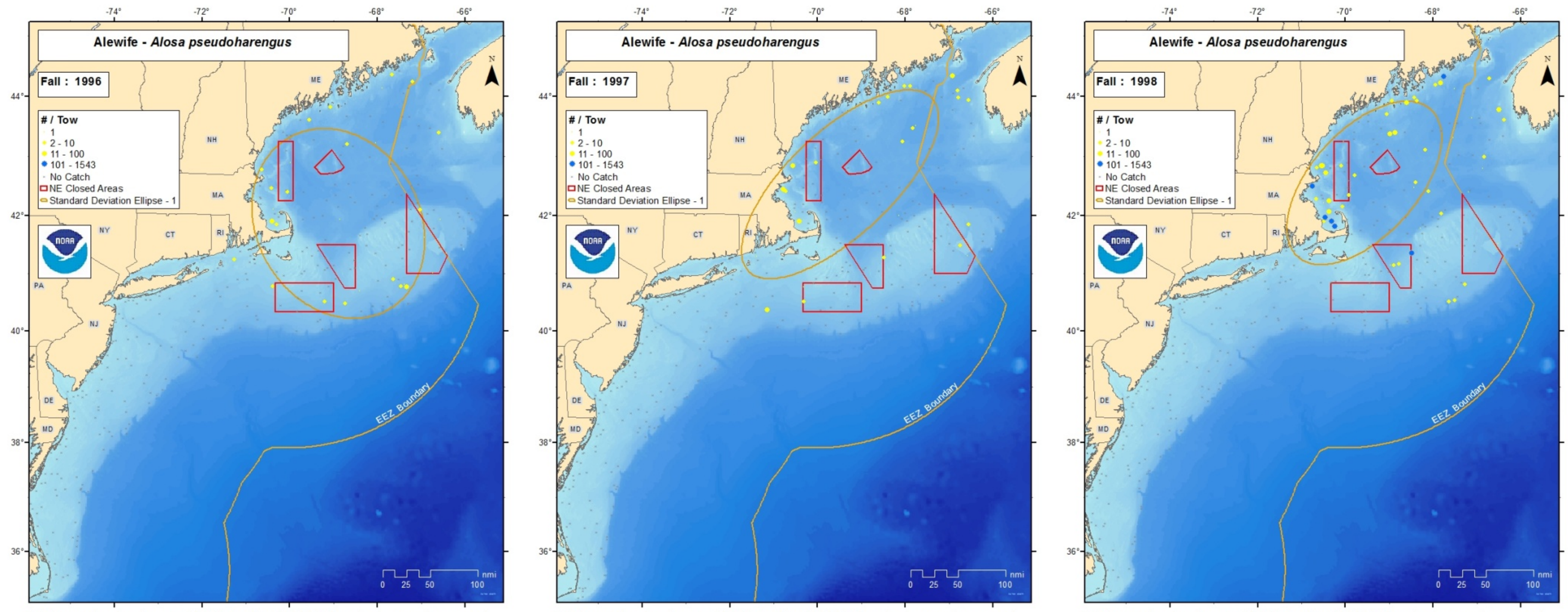


Figure 19. Annual standard deviational ellipses (one standard deviation) for *Alosa pseudoharengus* catches (numbers per tow) during the 1996-1998 NEFSC fall bottom trawl surveys.

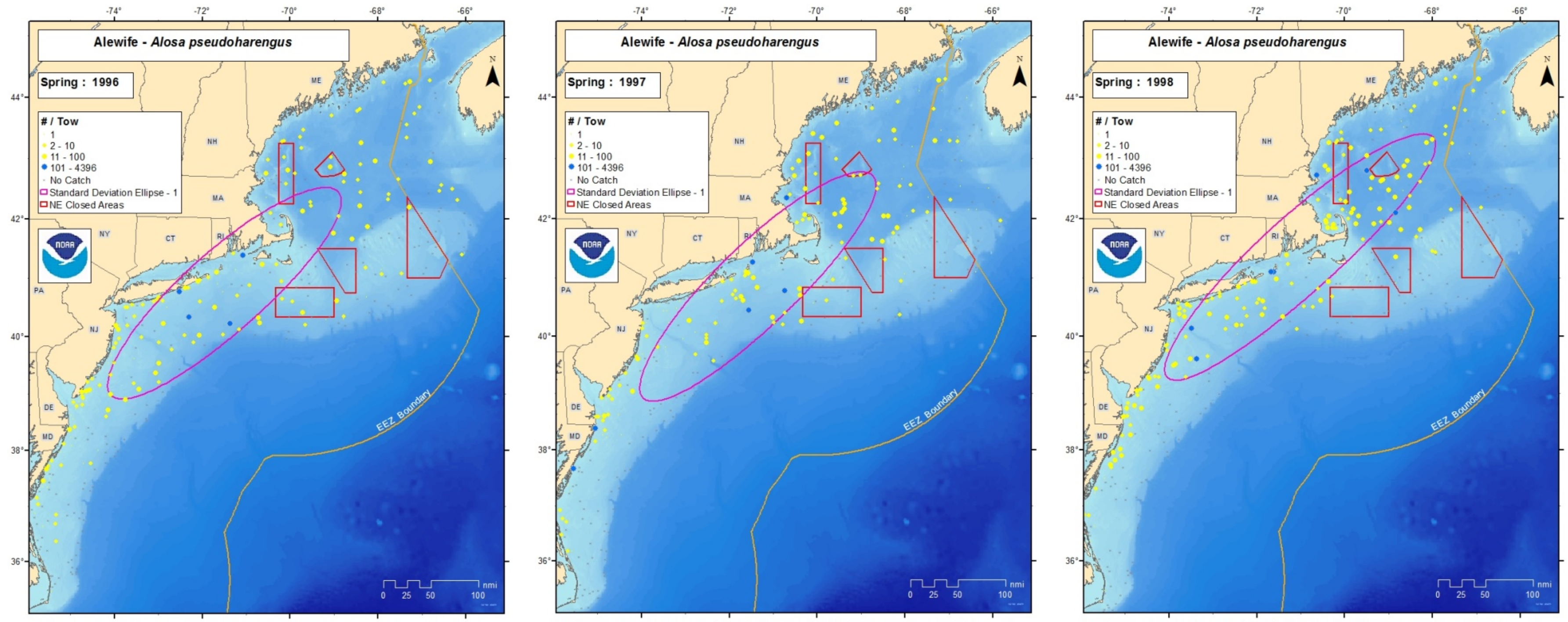


Figure 20. Annual standard deviational ellipses (one standard deviation) for *Alosa pseudoharengus* catches (numbers per tow) during the 1996-1998 NEFSC spring bottom trawl surveys.

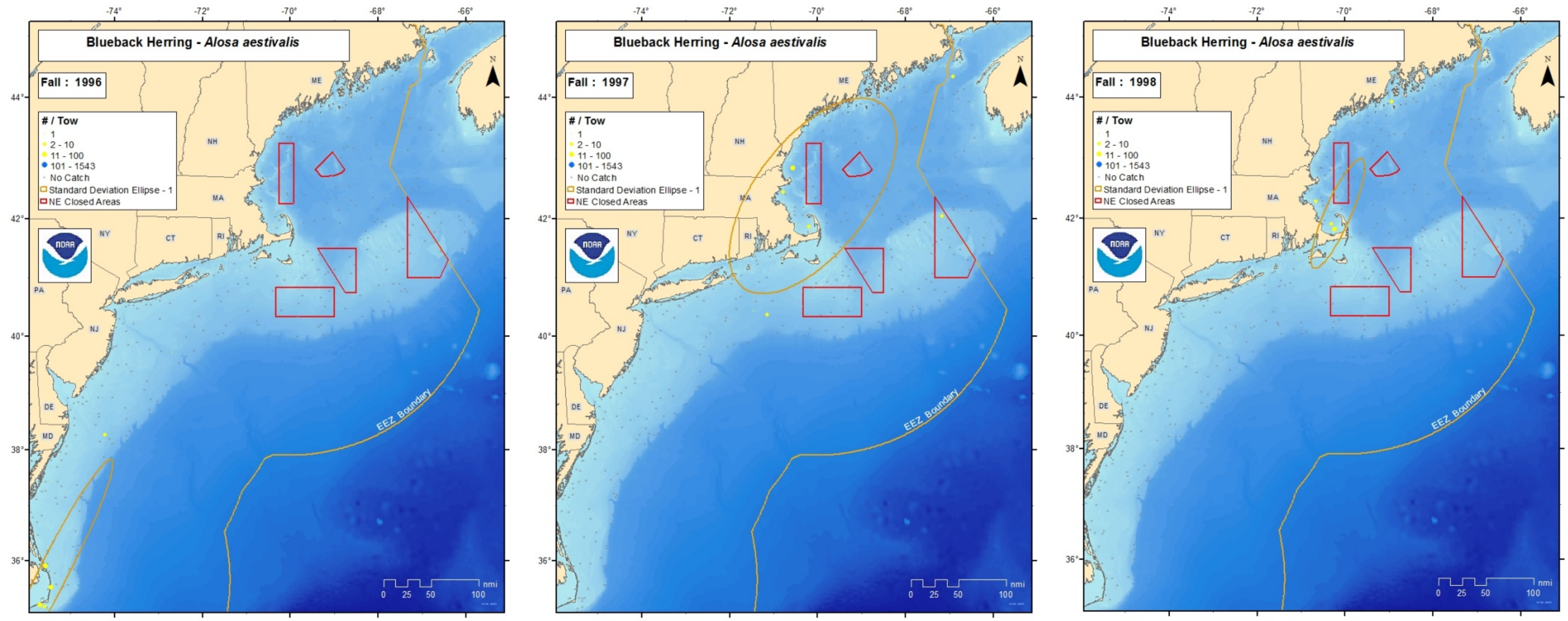


Figure 21. Annual standard deviational ellipses (one standard deviation) for *Alosa aestivalis* catches (numbers per tow) during the 1996-1998 NEFSC fall bottom trawl surveys.

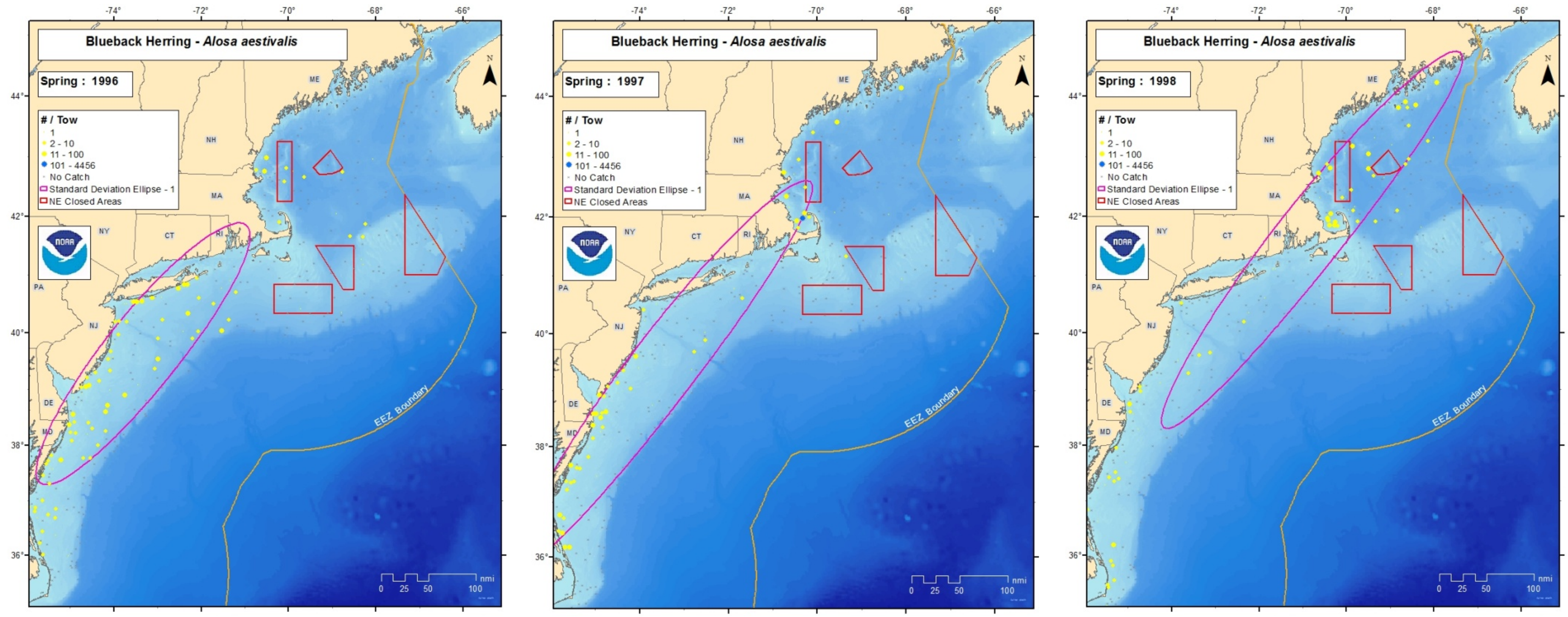


Figure 22. Annual standard deviational ellipses (one standard deviation) for *Alosa aestivalis* catches (numbers per tow) during the 1996-1998 NEFSC spring bottom trawl surveys.

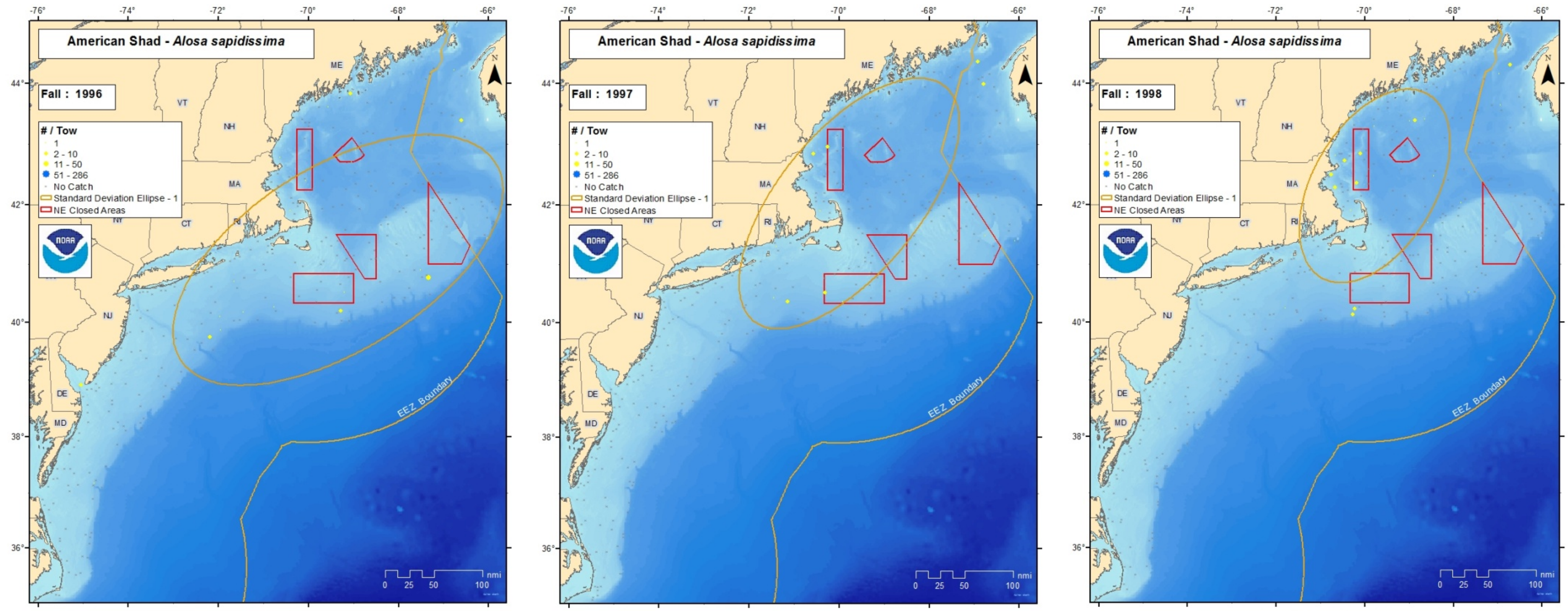


Figure 23. Annual standard deviational ellipses (one standard deviation) for *Alosa sapidissima* catches (numbers per tow) during the 1996-1998 NEFSC fall bottom trawl surveys.

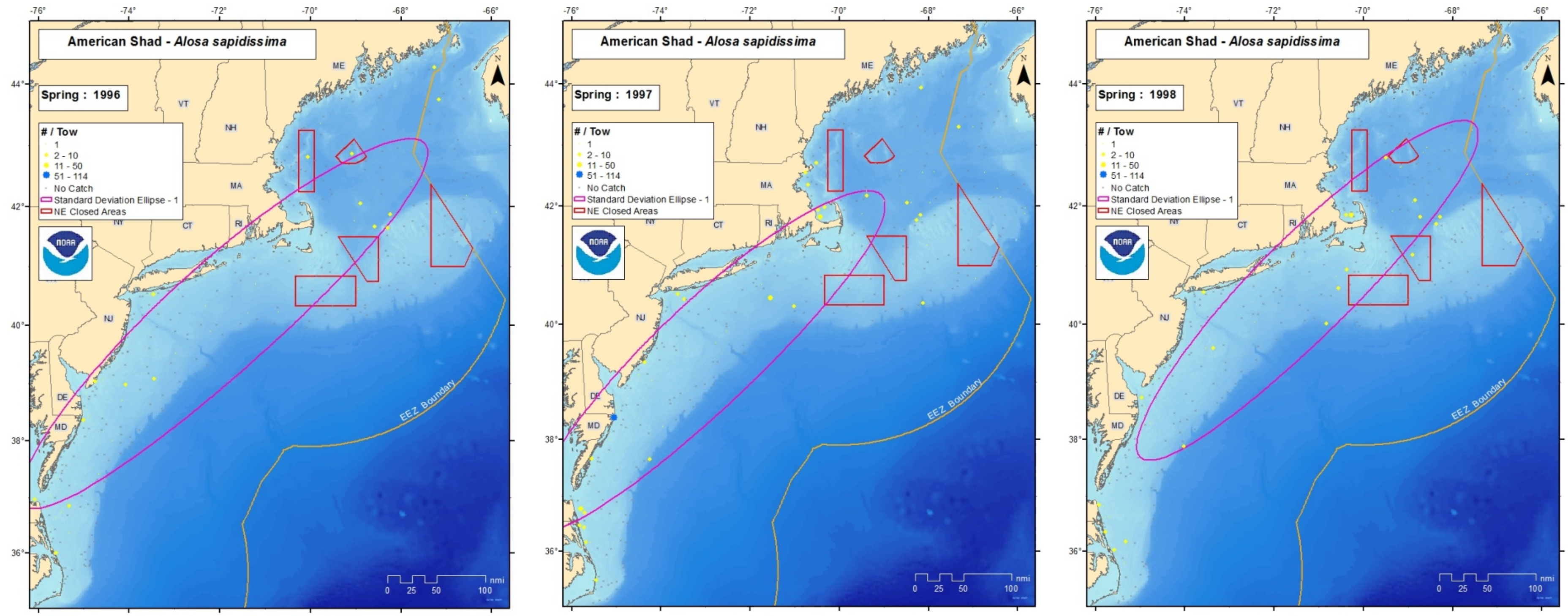


Figure 24. Annual standard deviational ellipses (one standard deviation) for *Alosa sapidissima* catches (numbers per tow) during the 1996-1998 NEFSC spring bottom trawl surveys.

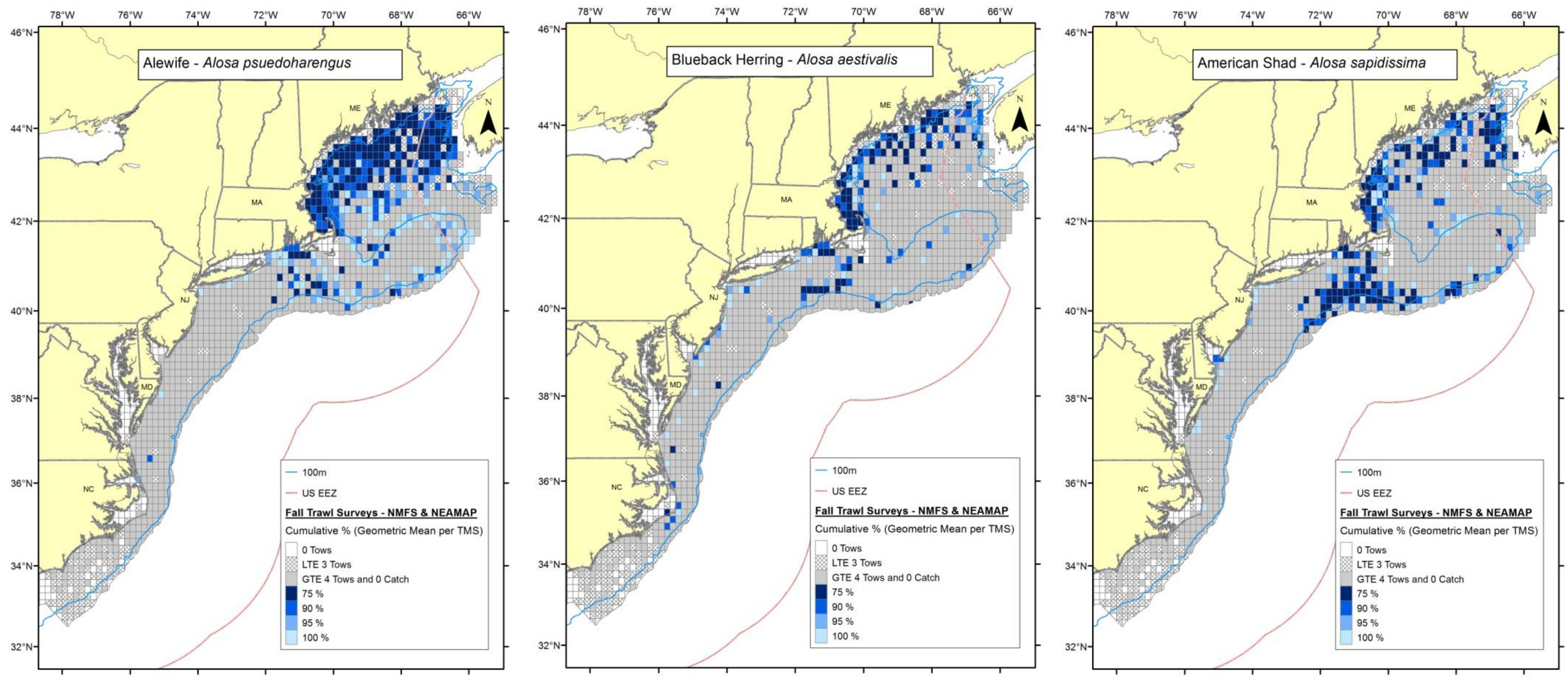


Figure 25. Distribution maps showing cumulative percentages (75, 90, 95 and 100%) of the geometric mean densities of *Alosa pseudoharengus*, *A. aestivalis*, and *A. sapidissima* during the 1975-2010 NEFSC fall bottom trawl surveys.

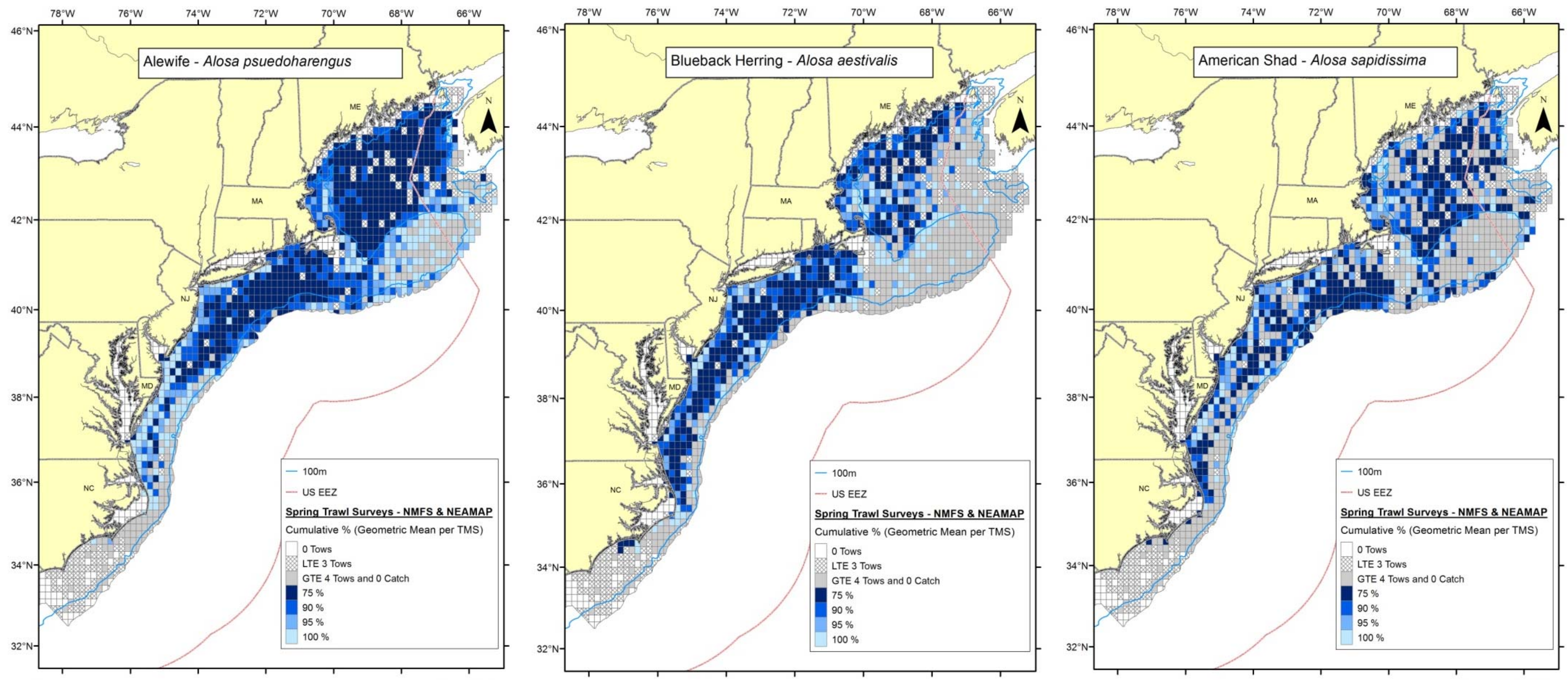


Figure 26. Distribution maps showing cumulative percentages (75, 90, 95 and 100%) of the geometric mean densities of *Alosa pseudoharengus*, *A. aestivalis*, and *A. sapidissima* during the 1976-2010 NEFSC spring bottom trawl surveys.

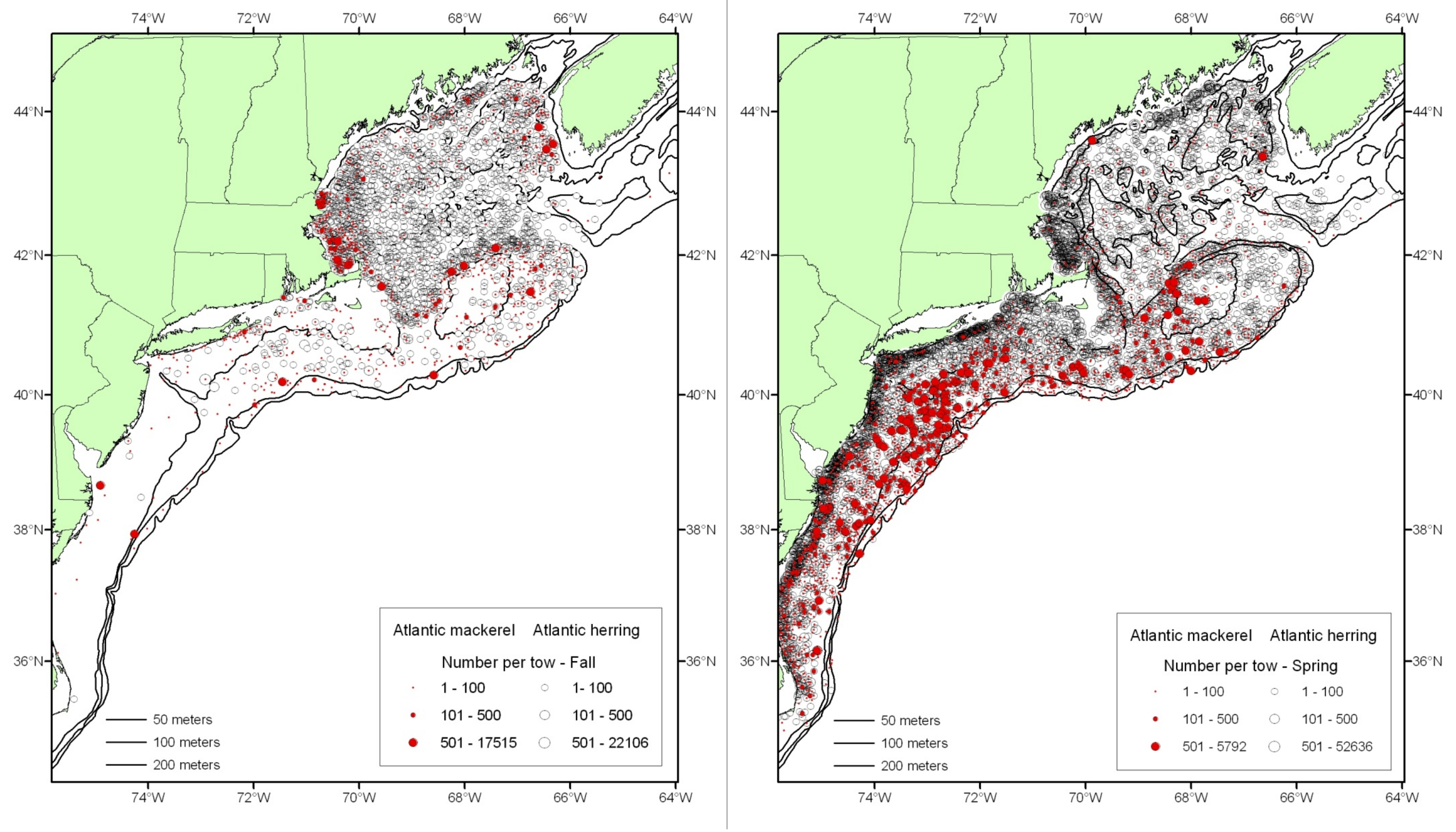


Figure 27. Distribution maps of Atlantic mackerel and Atlantic herring during NEFSC fall (left) and spring (right) bottom trawl surveys, 1976-2010.

		Bottom Trawl						Gillnet					
		Small mesh		**Med. mesh**		**Large mesh**		**Small mesh**		**Large mesh**		**X-large mesh**	
Species	**Year**	**Catch**	**CV**	**Catch**	**CV**	**Catch**	**CV**	**Catch**	**CV**	**Catch**	**CV**	**Catch**	**CV**
	1997	0.00		0.00		0.00		0.00		0.00		0.00	
	1998	0.07	1.85	0.00		0.00		0.01	0.30	0.13	0.28	0.02	0.91
	1999	45.35	2.06	0.00		0.00		0.07	0.81	0.07	1.96	0.00	
	2000	0.60	1.03	0.00		0.04	2.67	0.21	0.67	0.02	1.03	0.00	
	2001	0.93	0.80	0.00		0.00		0.12	0.62	0.00		0.00	
	2002	2.21	0.73	0.00		0.00		0.00		0.00		0.00	
	2003	0.00		0.00		0.00		0.02	1.68	0.00		0.00	
	2004	167.25	0.78	0.00		0.00		0.00		0.00		0.00	
	2005	1.89	0.73	0.00	0.83	0.00		0.06	1.50	0.00		0.00	
	2006	0.00		0.00		0.00		0.09	0.96	0.00		0.00	
	2007	10.41	4.76	0.00	2.55	0.00		0.00		22.37	0.86	0.00	
	2008	52.35	1.12	0.05	0.61	0.00		0.00		0.00		0.00	
	2009	3.79	0.72	0.05	0.87	0.00		0.00		0.00		0.00	
	2010	43.01	0.58	0.01	1.12	0.00		0.00		0.00		0.00	
Hickory Shad	1989	0.00		0.00		0.00		0.00		0.00			
	1990	0.00		0.00		0.00		0.00		0.00		0.00	
	1991	0.00		0.00		0.00		0.00		0.00			
	1992	0.00		0.00		0.00		0.00		0.00			
	1993	0.00		0.00		0.00		0.00		0.00			
	1994	0.00		0.00		0.00		0.11	0.17	0.00	0.63	0.00	
	1995	0.00		0.00		0.02	2.09	0.01	0.11	0.00		0.00	
	1996	8.92	0.57	0.00		0.00		0.16	0.16	0.30	0.49	0.00	
	1997	3.01	3.40	1.81	1.24	0.00		5.40	0.80	0.00	0.91	0.00	
	1998	0.00		0.00		0.00		0.47	0.39	0.00		0.00	
	1999	0.11	2.47	0.00		0.00		0.14	0.71	0.00		0.00	
	2000	0.00		0.00		0.00		0.02	1.07	0.03	1.28	0.00	
	2001	0.44	0.53	2.66	1.21	0.00		10.94	0.54	0.05	0.87	0.00	
	2002	0.00		0.00		0.00		1.28	1.15	0.00		0.00	
	2003	4.44	2.70	0.14	0.71	0.00		1.52	1.73	0.00		0.00	
	2004	5.44	1.60	0.00		0.00		0.00		19.91	1.25	0.00	
	2005	7.11	0.42	0.07	2.60	0.15	0.62	0.12	1.27	0.00		0.00	
	2006	3.69	0.74	0.14	6.42	0.00		0.00		0.00		0.00	
	2007	1.44	3.17	0.15	0.43	0.00	0.53	0.00		0.44	0.77	0.00	
	2008	0.24	0.97	0.02	0.78	0.00		0.00		0.00		0.00	
	2009	0.12	1.58	0.05	0.99	0.00		1.35	2.36	0.00		0.00	
	2010	0.01	1.04	0.00	1.08	0.01	0.44	0.32	0.70	0.00		0.00	

Table A5: New England total annual incidental catch (mt) and the associated coefficient of variation by mesh category for bottom trawl and gillnet for each individual species. Herring NK represents unknown herring. Midwater trawl estimates are only included beginning in 2005.

		Bottom Trawl						**Gillnet**					
		Small mesh		**Med. mesh**		**Large mesh**		**Small mesh**		**Large mesh**		**X-large mesh**	
Species	**Year**	**Catch**	**CV**	**Catch**	**CV**	**Catch**	**CV**	**Catch**	**CV**	**Catch**	**CV**	**Catch**	**CV**
Alewife	1989	4.22	0.69	0.32	1.64	0.12	0.98	0.00		0.00		0	
	1990	11.91	1.91	0.00		43.36	0.69	0.00		0.00			
	1991	3.21	0.74	0.57	1.28	0.24	1.17	0.00		0.00		0.00	
	1992	1.16	0.62	0.00		0.76	0.64			0.00		0.00	
	1993	33.75	0.61	0.00		0.06	1.89			0.00		0.00	
	1994	0.00		0.00		0.08	1.56	0.00		0.00		0.00	
	1995	2.10	1.37	0.00		0.00		0.00		0.09	1.07	0.00	
	1996	38.37	0.39	0.00		0.00		0.00		1.31	1.02	0.00	
	1997	10.05	3.17	0.00		0.03	1.39	0.00		0.00		0.00	
	1998	80.88	1.47	0.00		0.00		0.00		0.00		0.00	
	1999	2.96	1.24	0.00		0.00		0.00		0.00		0.00	
	2000	20.30	0.88	0.00		0.00		0.00		0.00		0.00	
	2001	88.28	1.10	0.00		0.66	1.22	0.00		0.00		0.00	
	2002	1.16	0.80	0.00	2.33	0.04	0.88	0.00		0.00		0.00	
	2003	38.21	0.58	0.00		0.65	0.40	0.00		0.03	0.66	0.00	
	2004	21.02	0.60	0.00	0.88	0.28	0.35	0.00		0.04	0.55	0.00	
	2005	11.53	0.84	0.00	0.13	1.45	0.94	0.00		0.02	0.56	0.00	
	2006	15.68	0.52	0.00		0.18	0.50	0.00		0.00		0.00	
	2007	258.45	0.41	0.00		0.93	0.65	0.00		0.00		0.02	1.41
	2008	31.31	0.87	0.00		0.53	0.28	0.00		0.00		0.00	
	2009	27.75	0.57	0.00		3.52	0.65	0.00		0.01	0.63	0.00	
	2010	26.81	0.43	0.10	1.81	1.71	0.18	0.00		0.02	0.51	0.00	0.84
American Shad	1989	38.90	0.89	0.00		6.53	0.33	0.00		0.00		0.00	
	1990	2.95	0.56	0.00		15.91	0.51	0.00		0.00			
	1991	6.87	0.50	0.28	1.31	63.63	0.33	0.00		0.00		0.00	
	1992	6.87	0.58	0.00		49.67	0.42			0.00		0.00	
	1993	38.25	0.68	0.00		11.42	0.41			0.00		0.00	
	1994	18.89	0.66	0.12	0.69	3.86	0.43	0.00		1.12	0.88	0.00	
	1995	1.24	0.83	0.03	0.99	5.25	1.18	0.00		8.85	0.29	0.04	0.84
	1996	0.36	12.72	0.04	0.00	0.64	1.07	0.00		27.82	0.48	0.00	
	1997	2.10	4.25	0.00		11.58	0.68	0.00		4.86	0.46	0.15	1.04
	1998	12.95	0.32	0.00		4.03	4.93	0.00		7.21	0.49	0.98	0.91
	1999	0.10	1.24	0.00		0.83	0.70	0.00		4.75	0.86	1.40	1.15
	2000	0.00		0.00		1.50	1.20	0.00		4.13	0.52	0.12	0.95
	2001	0.84	1.27	0.05	0.66	1.08	0.54	0.00		0.07	1.66	0.00	

Species	Year	Bottom Trawl						Gillnet					
		Small mesh		Med. mesh		Large mesh		Small mesh		Large mesh		X-large mesh	
		Catch	CV	Catch	CV	Catch	CV	Catch	CV	Catch	CV	Catch	CV
	2002	4.39	1.47	0.00		0.17	0.71	0.00		17.10	0.44	0.08	1.08
	2003	7.35	0.47	0.00	0.85	1.17	0.31	0.00		1.62	1.00	0.56	0.88
	2004	10.90	0.55	0.00	1.37	0.61	0.30	0.00		2.49	0.27	0.14	0.73
	2005	6.88	0.53	0.00	0.12	0.72	0.20	0.00		2.02	0.26	0.07	0.37
	2006	2.58	0.70	0.00	0.62	0.46	0.24	0.00		9.46	1.18	0.00	
	2007	0.75	0.49	0.00		0.70	0.26	0.00		27.86	0.52	0.00	
	2008	1.15	0.86	0.05	0.61	1.75	0.29	0.00		28.27	0.37	0.03	1.10
	2009	16.21	0.56	0.00		1.77	0.23	0.00		7.65	0.28	0.18	0.79
	2010	7.80	0.35	0.02	1.64	3.40	0.12	0.00		9.55	0.19	0.06	0.43
	1989	4.58	0.72	0.00		3.62	0.89	0.00		0.00		0.00	
	1990	5.79	1.66	0.00		13.85	1.42	0.00		0.00			
	1991	57.20	0.58	0.01	0.93	0.05	0.75	0.00		0.00		0.00	
	1992	85.38	1.46	0.00		0.47	0.72			0.00		0.00	
	1993	96.08	0.61	0.00		0.64	0.59			0.00		0.00	
	1994	32.94	0.37	0.00		0.05	0.63	0.00		6.64	0.84	0.00	
	1995	58.98	0.83	0.00		0.09	0.48	0.00		104.57	0.71	0.00	
	1996	1.53	1.35	0.00		0.00		0.00		0.23	0.73	0.00	
	1997	51.49	4.66	0.00		0.07	1.41	0.00		0.00		0.00	
	1998	0.00		0.00		0.00		0.00		0.17	0.72	0.00	
Blueback Herring	1999	199.81	0.61	0.00		6.74	1.83	0.00		0.00		0.00	
	2000	1.41	0.88	0.00		0.02	1.49	0.00		0.00		0.00	
	2001	41.48	1.00	0.00		0.03	0.97	0.00		0.00		0.00	
	2002	159.90	0.33	0.02	1.31	1.15	0.56	0.00		0.64	1.23	0.00	
	2003	272.92	0.62	0.12	0.46	5.97	0.35	0.00		0.01	0.96	0.00	1.36
	2004	49.61	0.60	0.02	0.80	4.47	0.53	0.00		1.77	0.71	0.06	0.54
	2005	14.73	0.75	0.02	0.16	1.01	0.38	0.00		0.23	0.80	0.00	0.90
	2006	2.55	1.01	0.12	0.77	0.48	0.40	0.00		0.00		0.00	
	2007	38.36	0.60	0.01	8.19	0.28	0.45	0.00		0.01	1.32	0.00	
	2008	13.47	0.85	0.00		0.26	0.41	0.00		0.02	1.31	0.00	
	2009	42.59	0.57	0.00		0.25	0.60	0.00		0.03	0.84	0.00	
	2010	8.59	0.46	0.07	0.48	1.13	0.41	0.00		0.07	0.39	0.00	
	1989	6.83	1.07	0.00		0.25	1.00	0.00		0.00		0.00	
	1990	10.95	1.90	0.00		207.24	1.09	0.00		0.00			
	1991	21.44	1.35	6.35	0.87	0.64	1.07	0.00		0.00		0.00	
Herring NK	1992	313.19	0.47	0.00		4.92	0.55			0.00		0.00	
	1993	9.70	0.81	0.00		5.05	0.66			0.00		0.00	
	1994	0.35	0.99	0.00		1.91	0.60	0.00		6.73	0.84	0.00	
	1995	44.36	1.69	0.00		0.60	0.40	0.00		3.69	0.59	0.00	
	1996	20.46	0.54	0.07	0.00	0.27	0.68	0.00		0.00		0.30	0.99

Species	Year	Bottom Trawl						Gillnet					
		Small mesh		Med. mesh		Large mesh		Small mesh		Large mesh		X-large mesh	
		Catch	CV	Catch	CV	Catch	CV	Catch	CV	Catch	CV	Catch	CV
	1997	61.89	4.64	5.20	0.62	0.38	0.77	0.00		0.04	1.02	0.04	2.28
	1998	0.00		0.00		0.18	1.27	0.00		0.00		0.00	
	1999	83.28	1.59	0.00		0.00		0.00		0.03	1.15	0.00	
	2000	14.31	0.70	0.00		0.44	1.48	0.00		0.00		0.00	
	2001	0.00		0.00		0.00		0.00		0.05	1.54	0.00	
	2002	73.95	1.91	0.00	0.77	0.35	0.73	0.00		0.00		0.00	
	2003	14.49	1.28	0.00		0.76	0.58	0.00		0.03	0.59	0.00	
	2004	9.24	0.64	0.00		0.22	0.59	0.00		0.02	0.60	0.00	1.16
	2005	2.97	1.34	0.01	0.12	0.23	0.29	0.00		0.16	0.55	0.01	0.90
	2006	57.15	1.50	0.05	0.63	0.33	0.57	0.00		1.98	0.56	0.27	0.99
	2007	72.27	2.94	0.00		0.15	0.51	0.00		0.00		0.00	
	2008	97.08	0.58	0.00		0.09	0.62	0.00		0.00		0.00	
	2009	14.70	1.51	0.00		0.30	0.39	0.00		0.63	0.62	0.00	
	2010	8.27	0.93	0.00		0.26	0.68	0.00		0.29	0.46	0.00	0.84
	1989	0.00		0.00		0.00		0.00		0.00		0.00	
	1990	0.00		0.00		0.00		0.00		0.00			
	1991	0.00		0.00		0.00		0.00		0.00		0.00	
	1992	0.00		0.00		0.00				0.00		0.00	
	1993	0.00		0.00		0.00				0.00		0.00	
	1994	0.00		0.00		0.10	0.63	0.00		0.00		0.00	
	1995	0.00		0.00		0.00		0.00		0.00		0.00	
	1996	17.26	1.24	0.00		0.00		0.00		0.00		0.00	
	1997	3.43	3.40	0.00		0.25	0.81	0.00		0.00		0.00	
	1998	38.40	1.48	0.00		0.00		0.00		0.00		0.00	
Hickory Shad	1999	4.40	0.70	0.00		0.00		0.00		0.00		0.00	
	2000	0.00		0.00		0.00	0.83	0.00		0.00		0.00	
	2001	66.32	0.45	0.00		0.20	0.76	0.00		0.00		0.00	
	2002	0.00		0.00		0.12	1.00	0.00		0.00		0.00	
	2003	2.53	1.05	0.00		0.06	0.93	0.00		0.25	0.48	0.01	0.84
	2004	7.98	0.79	0.00		0.06	0.39	0.00		0.04	0.84	0.00	
	2005	2.41	0.49	0.00	0.92	0.26	0.56	0.00		0.01	0.85	0.00	
	2006	9.19	1.14	0.00		0.13	0.32	0.00		0.02	1.88	0.02	1.05
	2007	1.74	0.43	0.00		0.24	0.36	0.00		0.28	1.33	0.00	
	2008	0.70	0.66	0.00		0.21	0.45	0.00		0.02	0.91	0.00	
	2009	1.88	0.83	0.02	0.30	0.15	0.35	0.00		0.17	0.61	0.00	
	2010	0.02	1.24	0.00		0.04	0.80	0.00		0.08	0.68	0.00	