Appendix 2 - R/H Catch Estimates

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

1.0 Estimates of incidental catch

1.1 Methods

Total incidental catch of river herring (alewife and blueback herring) and hickory and American shad (RHS) was quantified by fleet. Fleets included in the analyses were those sampled by the Northeast Fisheries Observer Program (NEFOP) and were stratified by region fished (Mid-Atlantic versus New England), time (year and quarter), gear group, and mesh size. Estimates that are restricted to a subset of trips identified as "targeted" trips for specific species were not used. These estimates are considered to be incomplete because the catches that occur on trips outside the trip subset are excluded. Furthermore, multiple species, such as Atlantic herring and mackerel, are often caught in a mixed fishery on the same trips during portions of the year. As such, defining targeted trips using a catch weight limit may lead to double counting of RHS incidental catch.

Region fished was defined using Statistical Areas for reporting commercial fishery data (Figure 1). The Mid-Atlantic region included Statistical Areas greater than 600, and New England included Statistical Areas 464 through 599. Gear groups included in the analyses were: bottom trawls, paired midwater trawls, single midwater trawls, gillnets, dredges, handlines, haul seines, longlines, pots/traps, purse seines, scallop trawl/dredge, seines and shrimp trawls. Bottom trawls and gillnets were further stratified into mesh groups. The estimated levels of precision when gillnet and bottom trawl incidental catches were quantified across all mesh sizes were very similar, and not consistently lower, than the precision estimates for these gears when estimated by mesh category. Since there was no gain in precision when we did not stratify by mesh, we split bottom trawl and gillnets into the following mesh categories:

Mesh category	Bottom Trawl	Gillnet
small	mesh $\leq$ 3.5	mesh < 5.5
medium	3.5 < mesh < 5.5	---
large	mesh $\geq$ 5.5	5.5 $\leq$ mesh < 8
x-large	---	mesh $\geq$ 8

Single and paired midwater trawls were split into separate fleets because the majority of both mackerel and herring landings during 2005-2010 were from paired midwater trawls, and the total catch-to-kept ratios varied between midwater trawl types.

The combined ratio method (Wigley et al 2007) is the standard discard estimation method implemented in NEFSC stock assessments. We used this method to quantify and estimate the precision (CV) of RHS total incidental catch for 1989 – 2010 across all fleets. Incidental catch estimates for the midwater trawl fleet are only provided for 2005-2010

because the estimates are most accurate as a result of improved sampling methodologies described below. Estimates of the precision are necessary in order to evaluate significant differences between incidental catch estimates by fleet and year.

Marked improvements to NEFOP sampling methodologies occurred in the high-volume midwater trawl (MWT) fisheries beginning in 2005, limiting the interpretability of estimates from these fleets in prior years. The NEFOP currently deploys specially-certified observers on paired and single midwater trawl vessels and purse seine vessels. NEFOP coverage of these high-volume fisheries that pump catch began in 2003 but the sampling focused on marine mammal interactions. In 2005, the focus of the sampling changed and the priorities became quantification of groundfish bycatch. At this time, the NEFOP implemented the catch composition log and observers began sampling the catches using a basket subsampling methodology in order to more accurately estimate catch weights over the course of pumping operations. At the same time, NEFOP protocols also required a more accurate quantification of the catches culled by the crew. Therefore, incidental catch estimates are provided beginning in 2005 because they are considered more accurate.

The NEFOP data used in this analysis were aggregated at the trip level. The sampling unit for the NEFOP database is a trip (Wigley et al. 2007) and observer sea days are allocated at the trip and fleet level, in contrast to the haul level. In addition, hauls within a trip are not independent of one another and are considered to be pseudo-replicates. The numbers of trips included in the analyses, for the Mid-Atlantic and New England regions, are presented in Tables 1 and 2, respectively.

For each trip, NEFOP data were used to calculate a total catch to kept (t/k) ratio, where t represents the total (retained+discarded) catch of an individual species (e.g., alewife, American shad) and k is the kept weight of all species. Annual estimates of total incidental catch were derived by quarter. Imputations were used for quarters with one or less observed trips.

The t/k ratios were expanded using a raising factor to quantify total incidental catch. With the exception of the midwater trawl fleets, total landed weight of all species (from the dealer database) was used as the raising factor. Total landings from the dealer database are considered to be more accurate than those of the VTR database because VTR landings represent a captain's hail estimate. However, for the MWT fleets, we were unable to use the dealer data to estimate the kept weight of all species when stratifying by fishing area. When the area allocation (AA) tables were developed, MWT was not included in effort calculations because of difficulties determining effort for paired MWTs. Only those gears with effort information could be assigned to a Statistical Area. Given these limitations, VTR data were used as the expansion factor for the MWT fleet.

When quantifying incidental catch across multiple fleets, total kept weight of all species is an appropriate surrogate for effective fishing power because it is likely that all trips will not exhibit the same attributes (Wigley et al 2007). The use of effort without standardization makes the implicit assumption that effort is constant across all vessels, thereby resulting in a biased effort metric.

1.2 Results

1.2.1 Temporal distribution of incidental catches

The temporal distribution of incidental catches was summarized by quarter and fishing region (i.e., New England versus Mid-Atlantic), for the most recent six-year period (2005-2010), to take into account any effects that the most recent management changes may have had on the fleets included in the analyses. The gear types which exhibited the highest incidental catches of the combined four species consisted of bottom trawls, midwater trawls and gillnets. These gears comprised 92% of the total incidental catches in the Mid-Atlantic from all gear types and 97% in New England.

Incidental catches of the four species combined varied by region and quarter for each gear type. For the three predominant gear types, most of the catch of the four species combined was taken in midwater trawls (72%, of which 53% was from paired midwater trawls and the rest from single midwater trawls), followed by 24% in small mesh bottom trawls and 3% in large mesh gillnets (Table 3). Most of the catch (58%) occurred in the New England region where catches were higher for all three gear types; 36% taken in midwater trawls, followed by 18% in small mesh bottom trawls and 3% in large mesh gillnets. The highest quarterly catch (34%) occurred during Quarter 1 (Q1) in the Mid-Atlantic, of which the majority (32%) was taken in midwater trawls. The second and third highest quarterly catches of all four species occurred during Q4 (21%) and Q2 (14%) in New England. About 16% and 11% of the catches in New England during Q4 and Q2, respectively, were taken in midwater trawls.

Catches of all four species taken in midwater trawls during Q1 in the Mid-Atlantic and during all four quarters in New England comprised 69% of the total incidental catch during 2005-2010 (Table3). Small mesh bottom trawl catches in New England comprised an additional 19% of the total incidental catch and were highest during Q1 (7%) followed by Q3 (5%), Q4 (4%) and Q2 (3%). Catches in large mesh gillnets were highest in New England, comprising 3% of the total incidental catch, and were highest during Q3 and Q4 (both totaling 1%).

Given the similar migration patterns between the two shad species and between alewife and blueback herring, incidental catches were also summarized separately for river herring and shads. Shad catches occurred primarily in midwater trawls (42% of which 32% were from paired midwater trawls and the rest from single midwater trawls), followed by large mesh gillnets (27%) and small mesh bottom trawls (26%, Table 4). Shad catches were highest in the New England region (69%) and ranked from high to low were 29%, 23% and 13% for midwater trawls, large mesh gillnets and small mesh bottom trawls, respectively. Quarterly trends in shad catches were highly variable. The highest quarterly catches of shad occurred in midwater trawls during Q4 in New England (13%) and during Q1 in the Mid-Atlantic (12%), followed by catches taken during Q3 (9%) and Q4 (9%) in large mesh gillnets in New England.

River herring catches also occurred primarily in midwater trawls (76%, of which 56% were from paired midwater trawls and the rest from single midwater trawls), followed by small mesh bottom trawls (24%, Table 5). Catches of river herring in gillnets were negligible. Across gear types, catches of river herring were greater in New England (56%) than in the

Mid-Atlantic (44%). The percentages of midwater trawl catches of river herring were similar between New England (37%) and the Mid-Atlantic (38%). However, catches in New England small mesh bottom trawls were three times higher (18%) than those from the Mid-Atlantic (6%). Overall, the highest quarterly catches of river herring occurred in midwater trawls during Q1 in the Mid-Atlantic (35%), followed by catches in New England during Q4 (16%) and Q3 (11%). Quarterly catches in small mesh bottom trawls were highest in New England during Q1 (7%) and totaled 3-4% during each of the other three quarters.

1.2.2 Species-specific incidental catch estimates for 2005-2010

From 2005-2010, the total annual incidental catch of alewife ranged from 19.0-473.3 metric tons (mt) in New England and 8.9-256.2 mt in the mid-Atlantic. The dominant gear varied across years between paired midwater trawls and bottom trawls (Figure 2). Corresponding estimates of precision exhibited substantial interannual variation and ranged from 0.28-3.12 across gears and regions. In all years and regions, the small mesh category dominated alewife bottom trawl catches (Figure 3). With the exception of 2007, alewife catches in the mid-Atlantic were greatest in the first quarter and dominated by paired and single midwater trawls (Figure 4). In quarters 2-4, mid-Atlantic alewife catches were primarily from small mesh bottom trawls. In contrast, New England catches of Alewife generally increased with quarter, and with the exception of 2007, were consistently greatest in the fourth quarter. New England alewife catches represented a mixture of single midwater trawls, paired midwater trawls and small mesh bottom trawls.

Total annual blueback herring incidental catch from 2005-2010 ranged from 13.9–176.5 mt in New England and 1.2-382.6 mt in the mid-Atlantic. Across years paired and single midwater trawls exhibited the greatest blueback herring catches, with the exception of 2010 in the mid-Atlantic where bottom trawl was the most dominant gear (Figure 5). Corresponding precision estimates ranged from 0.27 – 3.65. The small mesh category dominated blueback herring bottom trawl catches (Figure 6). Similar to alewife, blueback herring catches were greatest in the 1st quarter in the Mid-Atlantic and, with the exception of 2007, in the fourth quarter in New England. In the mid-Atlantic, blueback herring catches were predominantly from midwater trawls. While small and medium mesh bottom trawls comprised approximately 60% of the total annual mid-Atlantic catch in 2007, the magnitude of this 2007 catch was small compared to other years. In New England, catches were largely from midwater trawls and to a lesser extent small mesh bottom trawls.

Total annual American shad incidental catches from 2005-2010 were generally less than that of the river herring species and ranged from 12.7–53.2 mt in New England and 5.9-36.6 mt in the mid-Atlantic. In contrast to both river herring species, the greatest annual American shad catches were due to gillnets as well as single MWTs, paired MWTs, and bottom trawls. Corresponding coefficients of variation ranged from 0.19 – 10.7. Within the bottom trawl fleet, the small mesh category generally exhibited the greatest catches; however, American shad were also caught in medium and large mesh bottom trawl fleets (Figure 9). Across regions and years, the large-mesh category generally dominated gillnet catches. Similar to the river herring species, American shad catches were greatest during the first quarter in the mid-Atlantic and the fourth quarter in New England. However, in contrast to the river herring species, the primary gears were more evenly distributed between midwater trawls, bottom trawls and large-mesh gillnets.

Total annual 2005-2010 hickory shad incidental catch was the smallest of all RHS species and ranged from 0.1–11.8 mt in New England and 1.0-8.7 mt in the mid-Atlantic. Across years, the dominant gear varied between bottom trawls, paired midwater trawls and gillnets (Figure 11). Precision estimates varied annually and ranged from 0.19–2.9 across gears and regions. Bottom trawl catches of hickory shad were predominantly comprised of the small mesh category, where gillnet catches were from both small and large mesh categories (Figure 12). Mid-Atlantic catches were more evenly distributed over quarter than for other RHS species, and were primarily comprised of small mesh bottom trawl and small and large mesh gillnets (Figure 13). The majority of New England quarterly catches was from midwater trawls, small-mesh bottom trawls and to a lesser extent large-mesh bottom trawls and gillnets.

Total annual incidental catch of unknown herring from 2005-2010 ranged from 5.2–228.2 mt in New England and 0.1 – 163.4 mt in the mid-Atlantic. The dominant gear by year and region varied between gillnet, paired MWT, single MWT, bottom trawl and the 'other' category (Figure 14). Corresponding coefficients of variation range from 0.2-0.8. Small- and large-mesh categories dominated unknown herring bottom trawl and gillnet catches, respectively (Figure 15). Mid-Atlantic catches were generally greatest in the first quarter and were from paired MWT, single MWT, small-mesh bottom trawl and large-mesh gillnets. New-England catches were approximately evenly distributed across quarter and largely from small-mesh bottom trawls and single MWTs (Figure 16).

Species-specific annual incidental catch estimates and the associated coefficients of variation are presented in Appendix 1.

1.2.2.1 Validation of incidental catch estimates

Species-specific total catch and discard estimates can be used to quantify the amount kept by calculating the difference between the two estimates. These kept estimates can then be compared to species-specific landings obtained from the dealer or VTR databases to serve as validation. For both the river herring and shad species groups, kept estimates did not track the landings well (Figure 17). For Atlantic herring, however, landings and kept estimates were quite similar during the last 4-5 years of the time series. This consistency between kept and landed Atlantic herring estimates indicates that the employed methodology can be used to reconstruct landings. The discrepancy between landings and kept estimates of the RHS species suggests an inconsistency in the identification of these species at the ports of landing.

1.2.2.2 Fisheries conducted by the fleets used in the incidental catch estimates

The incidental catch estimates are based on fleets (ex: gear, region, mesh) rather than fishery directivity. In order to identify the directivity of each of the fleets used in the incidental catch analysis, we analyzed trends in mackerel, herring, *Illex*, *Loligo*, and silver hake landings by month, area and mesh size. The analysis clearly indicated substantial fishery directivity overlap within fleets. For example, trends in mackerel and herring landings by gear indicate that both species are caught predominantly by paired midwater trawls (Figure 18).

Graphs of catch by codend mesh size recorded in the NEFOP database for observed hauls indicated an overlap in mesh sizes used on midwater trawl tows when the

target species (i.e., targspec1 field in the NEFOP database) is either mackerel or Atlantic herring (Figure 19a). About 85% of mackerel midwater trawl catches and 96% of herring midwater trawl catches occurred with mesh sizes between 24 and 50 mm. Similar overlap in mesh size was apparent in bottom trawl tows targeting either mackerel or silver hake. Bottom trawl mesh sizes between 48 and 76 mm represented 99% of mackerel catches and 77% of silver hake catches (Figure 19b).

Some segregation in mackerel and herring 2005-2010 landings by Statistical Area was apparent (Figure 20a). The greatest proportions of herring midwater trawl landings occurred in New England (specifically Statistical Areas 512 through 522), whereas the greatest proportions of mackerel landings occurred in the Mid-Atlantic (Statistical Areas 612-622). However, there was some overlap in regional trends between the two species. For example, 20% of the total mackerel landings were from New England (Statistical Areas 525-537) and 19% of the total Atlantic herring landings were from the Mid-Atlantic. Similarly for bottom trawl landings, the greatest proportions of mackerel landings occurred in Mid-Atlantic statistical areas 612-622 and the greatest proportions of silver hake landings occurred in New England statistical areas 513-538 (Figure 20b). However, overlap was still apparent; 15% of total mackerel landings were caught in New England and 25% of total silver hake landings were from the Mid-Atlantic. Accordingly, Statistical Area alone does not appear to permit separation of fleets into fisheries.

Analysis of mackerel and herring landings by month and region indicated a mixed midwater trawl fishery from January-April in both the Mid-Atlantic and New England (Figure 21a). In the Mid-Atlantic, landings during January-April represented the vast majority (98%) of regional midwater trawl landings. Of the total January-April combined mackerel and herring landings from the Mid-Atlantic, between 24-39% were herring and 61–76% were mackerel. In New England, January-April landings only represented 21.7% of regional midwater trawl landings. Of the combined mackerel and herring landings, 32-41% were herring and 55-68% were mackerel. Analysis of mackerel, *Loligo* and silver hake bottom trawl landings by both region and month indicated a mixed fishery throughout the year (Figure 21b). While most mackerel landings occurred in January-April and most *Illex* landings occurred from June-October, silver hake and *Loligo* landings largely occurred throughout all months in both regions. Further examination of the distribution of January-April landings by Statistical Area indicated substantial overlap in both regions within both bottom trawl and midwater trawl fleets (Figure 22).

Based on trends in landings over time, region, gear and mesh category, and the strong evidence for mixed fisheries, it is not possible to clearly identify fishery directivity for each of the fleets used in the incidental catch analysis.

1.2.3 Spatial distribution of incidental catches

ArcGIS software (v. 10, ©ESRI) was used to produce maps of nominal fishing effort (days fished, from the Vessel Trip Reports), by ten-minute square (TNMS), for the gear types with the highest levels of incidental catch of each the four subject species during 2005-2010 (refer to Section 1.2.1). As previously noted, 2005-2010 was considered as the

reference time period because it takes into account any effects that the most recent management changes may have had on the temporal and spatial distributions of the fleets included in the analyses. Gear types that were mapped included small mesh bottom trawls, single midwater trawls, paired midwater trawls and large mesh gillnets. Each TNMS was shaded according to the cumulative percentage of the total effort for the mapped time period. For each gear type, CPUE (kept+discarded weight of each of the four species / days fished) was computed from NEFOP data using observed tows. It should be noted that the days fished data from the Vessel Trip Reports (VTR) differ from the days fished data used to compute CPUE. The latter type of data is more accurate because it represents the sum of the actual tow durations within each TNMS, whereas days fished data from the VTRs represent the product of the average tow duration and the number of tows conducted during a subtrip as reported by each captain. Likewise, the data resolution of the geographic location data used to map VTR effort data differs from that used to map the NEFOP CPUE data. Mapping of the VTR data by TNMS represents a post-stratification of the effort data because captains are only asked to report a single fishing location (as a Statistical Area and a single latitude/longitude location within the Statistical Area) within each Statistical Area that is fished during a trip. The assignment of NEFOP CPUE data to each TNMS is more accurate because catch and effort data are recorded for each tow location.

For each map, CPUE data were mapped as the center point of a TNMS and overlain on the fishing effort layer to determine: 1.) where CPUE levels were highest; 2.) whether high incidental catch rates coincided with high levels of fishing effort; and 3.) to characterize the variability in temporal and spatial trends in effort and CPUE with respect to the potential for establishing closed areas or gear restriction areas to reduce bycatch of the four alosid species. Maps from the 2005-2010 reference period were compared to the 1999-2004 period to determine the degree of spatial consistency in broad-scale patterns of fishing effort for each gear type and incidental catch rates of each species. For comparative purposes, CPUE data classes used in the map legends for each of the two time periods were the same within each gear type. For midwater trawls, nominal effort and CPUE were not mapped for 1999-2004 because VTRs were not mandatory for the midwater trawl herring fleet until 2001 and, as previously explained in Section 1.1, the methods used by NEFOP fishery observers to quantify large-volume catches in the midwater trawl fleets were most accurate beginning in 2005 and the number of midwater trawl trips sampled by NEFOP was much higher.

1.2.3.1 Maps of CPUE and effort, by fleet, for each species

As concluded in Section 1.2.1, most of the total incidental catch of river herring during 2005-2010, as well as the two shad species, occurred in midwater trawls (mainly in paired midwater trawls). Incidental catch rates of both alewife and blueback herring in paired midwater trawls during 2005-2010 were similar and were highest across broad areas in the western Gulf of Maine (SA 521 and 514 along and shoreward of the 100 m isobath), off the coast of central NJ (SA 612, 615 and 616), and scattered throughout southern New England (particularly off Rhode Island in Block Island Sound and along the southeast shore of Long Island, Figure 23). The highest catch rates of both species did not always coincide with the highest fleet effort. Catch rates of hickory shad in

paired midwater trawls were much lower than those of American shad and occurred primarily in the western Gulf of Maine (Figure 24). American shad catch rates were highest in the same general areas as river herring, with the exception that American shad catch rates were lower in southern New England.

The second highest levels of incidental catches of each of the four alosid species occurred in small mesh bottom trawls. Fishing effort in the small mesh bottom trawl fleet varied between 2005-2010 and 1999-2004. During 1999-2004, effort occurred across a broader area, in the western Gulf of Maine and was much higher in southern New England (Figure 25). Incidental catch rates of blueback herring and alewife were also different between the two time periods, with the highest rates occurring in and around Block Island Sound during 2005-2010, but occurred offshore, for blueback herring, in scattered TNMS within SA 612, 613, 615 and 616 during 1999-2004 (Figures 25 and 26). Similar to the paired midwater trawl fleet, the highest incidental catch rates of both species did not always coincide with the highest levels of effort (e.g., Block Island Sound catch rates during 2005-2010). Catch rates of American shad in small mesh bottom trawls (Figure 27) were much higher than for hickory shad (Figure 28), similar to catch rates of the two shad species in paired midwater trawls. Catch rates of American shad in small mesh bottom trawls varied between the time periods and were highest in the vicinity of Long Island Sound during 2005-2010, followed by a broad range of mostly contiguous offshore areas in the Mid-Atlantic and southern New England (between the 100 and 400 m isobaths). During 1999-2004, catch rates of American shad and hickory shad were highest in the offshore areas, particularly in the southern portion of SA 537 between the 100 and 400 m isobaths (Figure 27 and 28).

Of the four bycatch species, most of the incidental catch in large-mesh gillnet fleet consists of the two shad species. Although fleet effort was highest off MA and NH (mainly inside of 100 m) during 2005-2010, catch rates of American shad were highest in areas where the fleet's effort was lowest; in the central Gulf of Maine in SA 515 (Figure 29). Incidental catches of hickory shad were extremely low (Figure 30).

Some of the maps included in the analysis showed CPUE data within ten-minute squares which lacked VTR effort data. Where this disconnect occurred in state waters, it may have been attributable to the fact that those vessels were not required to have federal permits, and thus, not required to submit VTRs. When this disconnect occurred seaward of the boundary for state territorial waters, it may have been due to incomplete submittals of VTR data for all trips, but more likely was due to differences between the spatial resolution of the VTR and NEFOP effort data.

1.2.3.2 Maps of CPUE and effort, by fleet and quarter, for all four species combined

A second series of CPUE and effort maps was prepared for single and paired midwater trawls combined and small mesh bottom trawls, by quarter, during 2005-2010 because these two gear types comprised a majority of the incidental catches of all four species

during this time period (Table 3). Incidental catches of all four species were mapped on a quarterly basis to provide a comprehensive summary of the data in time and space. Within each of the two gear types, the CPUE and effort data are comparable across quarters.

During 2005-2010, catch rates of all four species combined were highest in midwater trawls during Q1 and Q4 and were distributed across very large areas, but the areas were not always contiguous (Figures 31 and 32). During Q1, catch rates were very high in Block Island Sound and off eastern Long Island as well as in scattered areas of the Mid-Atlantic off New Jersey (Figure 31). During Q4, catch rates were highest in the western Gulf of Maine, along the 100 m isobath between Cape Cod, Massachusetts and New Hampshire and were also very high in an area of low effort by the fleet located south of Martha's Vineyard (Figure 32).

During 2005-2010, catch rates of all four species combined were highest in small mesh bottom trawls during Q1 and Q2 and were also distributed across very large areas, but which were generally contiguous (Figures 33 and 34). During Q1, the highest catch rates occurred in and around Block Island Sound, followed secondarily by the area of highest effort which was located near the shelf edge and north of a the Southern Gear Restricted Area (polygon denoted as a dashed line in the Mid-Atlantic). The high catch rates in Block Island Sound occurred primarily in Statistical Area 538, and also adjacent portions of SA 611 and SA 537, but effort by the small mesh bottom trawl fleet is unknown.

1.2.3.3 Effectiveness of closed areas to reduce alosid bycatch

The establishment of year-round and/or seasonal closed areas (CAs) and/or gear restriction areas (GRAs) was evaluated as a potential management measure to reduce incidental catches of the subject alosid species. The degree of effectiveness of CAs and GRAs in accomplishing this objective is dependent on the degree of temporal and spatial overlap between the distribution of fishing effort for the fleets with the predominant bycatch and the distribution of the bycatch species, and more importantly, the interannual consistency of such overlap. If the highest incidental catches consistently occur across a reasonably small area each year, then CAs and/or GRAs may be effective. However, if the opposite situation is true, the size of the CA and/or GRA must be large in order to encompass the spatial extent of the interannual variability, and therefore, may not be practicable. In addition to these considerations, quantification of the effectiveness of CAs and GRAs is difficult for mobile species.

Maps of NEFSC spring and fall survey catches (presented in Part I) indicate that the seasonal and interannual distributions of all four species are highly variable in time and space. In addition, the analyses presented herein indicate that the incidental catches of all four bycatch species, as well as effort patterns in the predominant fleets which catch theses species are also highly variable in time and space. This is because of all four species undergo extensive coastwide migrations, which are largely influenced by water temperatures, and because the predominant gear types which incidentally catch these

species (e.g., Atlantic herring and Atlantic mackerel in the MWT fleet and *Loligo*, *Illex*, hakes, and Atlantic mackerel in the small mesh BT fleet) are seeking target species which are also highly migratory. For example, the interannual variability in the spatial distribution of fishing effort in the midwater trawl fleet was quite variable during 2005-2010 (Figure 35). There was less variability in the annual effort distributions for the small mesh bottom trawl fleet, but during some years (e.g., 2005 and 2007) very little effort occurred inshore (Figure 36). Commercial catches of Atlantic mackerel also showed substantial interannual variability in the spatial distribution of monthly catches (Figures 37 and 38).

In conclusion, as a result of the high degree of interannual and seasonal variability in the spatial distributions of the four bycatch species as well as in the fishing effort of for the midwater trawl and small mesh bottom trawl fleets which incidentally catch these species, closed areas are not considered to be an effective management measure for the reduction of incidental catch of the four species addressed herein.

Table 1: Total number of trips recorded for each fleet in the observer, dealer and VTR databases for the Mid-Atlantic. Landings from the VTR database were used as the raising factor to estimate catch in the midwater trawl fleets. For all other fleets, the dealer database was used.

	Number of trips									
	Bottom trawl						Midwater trawl			
	Small mesh		Medium mesh		Large mesh		Single		Paired	
Year	Observer	Dealer	Observer	Dealer	Observer	Dealer	Observer	VTR	Observer	VTR
1989	29	1,781	7	412	1	7				
1990	31	1,363	19	386	0	11			0	0
1991	61	1,711	20	361	4	100	5	0	0	0
1992	39	1,294	12	283	14	284			9	0
1993	6	1,167	1	103	7	441			14	0
1994	6	2,170	6	156	14	1,998	1	64	30	44
1995	60	2,918	3	330	53	3,332	0	120	33	50
1996	68	3,143	10	652	16	3,344	0	264	0	14
1997	41	3,426	9	692	5	3,711	0	210	0	6
1998	24	3,693	3	784	13	3,647	0	239	0	34
1999	26	3,250	9	777	5	3,865	0	205	0	26
2000	25	3,230	10	806	28	3,250	5	194	1	74
2001	42	2,684	12	879	44	3,886	0	170	0	56
2002	15	2,408	18	998	38	4,172	0	72	1	107
2003	21	1,637	51	795	11	4,208	0	115	5	195
2004	108	1,836	151	692	96	4,874	2	99	8	249
2005	74	1,086	101	466	88	6,478	4	81	11	221
2006	100	1,810	47	736	62	5,051	8	74	6	184
2007	86	1,711	139	714	159	3,899	1	86	2	83
2008	66	1,776	84	701	129	4,391	10	17	8	143
2009	169	2,031	125	661	162	4,737	5	27	20	162
2010	182	1,895	187	420	276	3,944	4	15	13	85

	Number of trips							
	Gillnet						Other	
	Small mesh		Large mesh		X-large mesh			
Year	Observer	Dealer	Observer	Dealer	Observer	Dealer	Observer	Dealer
1989	0	67	0	27			0	15,494
1990	0	137	0	1	0	3	1	16,633
1991	0	121	0	1			8	17,948
1992	0	100	0	5			15	17,042
1993	0	80	0	33			42	17,467
1994	83	85	58	57	20	24	42	15,086
1995	126	185	202	516	73	294	44	13,440
1996	133	343	172	531	65	638	24	14,109
1997	90	422	133	400	111	1,021	27	18,541
1998	100	699	130	456	73	1,403	36	16,378
1999	42	848	23	566	19	1,443	57	15,424
2000	49	1,110	17	543	18	1,954	72	15,308
2001	54	1,280	17	441	17	2,193	97	15,747
2002	34	1,267	10	376	11	2,139	96	16,653
2003	25	750	4	294	13	2,104	115	17,997
2004	12	1,303	6	475	38	1,409	330	16,892
2005	19	1,270	4	335	82	1,739	400	23,185
2006	20	1,160	7	500	32	1,470	144	25,122
2007	19	1,231	13	516	32	2,045	245	27,634
2008	7	905	2	642	44	2,029	506	25,958
2009	9	1,252	8	1177	43	1,693	433	25,787
2010	12	851	52	1122	91	1,455	283	16,538

Table 2: Total number of trips recorded for each fleet in the observer, dealer and VTR databases for New England. Landings from the VTR database were used as the raising factor to estimate catch in the midwater trawl fleets. For all other fleets, the dealer database was used.

	Number of trips									
	Bottom trawl						Midwater trawl			
	Small mesh		Medium mesh		Large mesh		Single		Paired	
Year	Observer	Dealer	Observer	Dealer	Observer	Dealer	Observer	VTR	Observer	VTR
1989	72	1,432	14	528	56	5,406			0	0
1990	33	1,665	4	355	54	5,851			0	0
1991	84	1,278	13	156	78	5,890	2	0	0	0
1992	56	1,348	1	120	68	5,531	0	0	0	0
1993	19	1,750	2	153	31	5,079	0	0	7	0
1994	9	3,426	2	239	27	8,341	0	306	4	53
1995	37	2,944	2	154	67	12,458	4	785	2	11
1996	47	2,665	2	51	39	12,475	0	902	0	18
1997	18	2,477	3	100	24	10,498	0	705	0	93
1998	5	2,979	0	94	11	11,095	0	508	0	170
1999	19	2,774	0	214	32	10,193	1	519	2	165
2000	8	2,297	9	124	99	11,064	7	463	0	367
2001	8	2,073	10	173	152	11,270	1	336	0	631
2002	35	1,625	29	221	214	11,138	0	371	0	651
2003	44	1,653	24	184	385	10,801	2	251	18	614
2004	86	1,283	83	152	525	9,343	23	254	60	581
2005	82	1,064	169	131	1341	8,388	43	265	91	463
2006	48	1,569	35	299	612	7,656	10	195	21	488
2007	57	1,745	18	213	618	7,461	10	84	11	235
2008	46	2,016	16	175	751	7,688	11	34	36	185
2009	195	1,895	23	270	877	7,373	10	48	67	223
2010	206	2,227	50	251	1049	6,043	29	57	106	213

	Number of trips							
	Gillnet						Other	
	Small mesh		Large mesh		X-large mesh			
Year	Observer	Dealer	Observer	Dealer	Observer	Dealer	Observer	Dealer
1989	0	10	0	497	0	1	40	28,527
1990	0	10	0	712			32	30,631
1991	0	50	0	1045	0	2	79	33,011
1992			0	1159	0	47	144	33,574
1993			0	1133	0	81	118	33,700
1994	0	3	61	2870	40	934	107	28,586
1995	0	8	105	6910	46	2,029	101	31,904
1996	0	21	55	6448	23	1,533	62	35,361
1997	0	12	51	5854	19	1,214	32	35,373
1998	3	14	115	5202	15	1,061	15	32,140
1999	1	6	98	3860	21	1,352	34	25,018
2000	0	17	107	4187	50	1,881	229	21,374
2001	1	17	69	4280	33	2,530	28	22,532
2002	0	14	91	3724	41	2,810	30	23,239
2003	0	20	326	4485	190	2,987	72	20,573
2004	1	16	699	3342	536	2,966	240	16,696
2005	0	39	587	3491	459	2,939	484	39,261
2006	0	67	142	3866	79	2,416	262	47,023
2007	2	78	132	5467	164	2,102	317	43,561
2008	3	27	170	6538	112	2,274	368	55,716
2009	2	12	313	6824	76	1,989	243	66,351
2010	0	22	1267	5374	771	2,653	383	150,268

Table 3: Proportion of 2005-2010 incidental catch of all river herring and shad species by region, fleet and quarter.

	Bottom Trawl				Gillnet		Paired MWT	Single MWT	Total MWT	Grand Total
	lg	med	sm	xlg	lg	sm	all	all		
Mid-Atlantic (SA >= 600)	**0.001**	**0.002**	**0.062**	**0.000**	**0.005**	**0.001**	**0.270**	**0.083**	**0.353**	**0.424**
Q1	0.000	0.001	0.018	0.000	0.002	0.000	0.246	0.074	0.320	0.342
Q2	0.000	0.000	0.012	0.000	0.001	0.000	0.016	0.007	0.023	0.037
Q3	0.000	0.000	0.023	0.000	0.000	0.000	0.000	0.001	0.002	0.026
Q4	0.000	0.001	0.010	0.000	0.001	0.000	0.007	0.000	0.008	0.020
New England (SA <= 500)	**0.007**	**0.000**	**0.177**	**0.000**	**0.028**	**0.000**	**0.259**	**0.105**	**0.364**	**0.576**
Q1	0.002	0.000	0.065	0.000	0.003	0.000	0.025	0.015	0.040	0.111
Q2	0.002	0.000	0.030	0.000	0.004	0.000	0.056	0.051	0.107	0.142
Q3	0.002	0.000	0.046	0.000	0.011	0.000	0.050	0.007	0.057	0.115
Q4	0.002	0.000	0.037	0.000	0.010	0.000	0.128	0.031	0.159	0.208
Grand Total	**0.008**	**0.002**	**0.239**	**0.000**	**0.033**	**0.001**	**0.529**	**0.188**	**0.716**	**1.000**

Table 4: Proportion of 2005-2010 incidental catch of American and hickory shad by region, fleet and quarter.

	Bottom trawl				Gillnet		Paired MWT	Single MWT	Total MWT	Grand Total
	lg	med	sm	xlg	lg	sm	all	all		
Mid-Atlantic (SA >= 600)	**0.004**	**0.012**	**0.115**	**0.000**	**0.041**	**0.008**	**0.115**	**0.016**	**0.132**	**0.312**
Q1	0.001	0.006	0.030	0.000	0.014	0.003	0.103	0.014	0.117	0.172
Q2	0.001	0.001	0.022	0.000	0.012	0.001	0.010	0.001	0.011	0.049
Q3	0.001	0.001	0.045	0.000	0.004	0.002	0.000	0.000	0.001	0.054
Q4	0.001	0.004	0.018	0.000	0.011	0.002	0.002	0.000	0.003	0.038
New England (SA <= 500)	**0.027**	**0.000**	**0.140**	**0.001**	**0.233**	**0.000**	**0.208**	**0.078**	**0.286**	**0.688**
Q1	0.007	0.000	0.036	0.000	0.028	0.000	0.019	0.006	0.025	0.096
Q2	0.007	0.000	0.030	0.000	0.032	0.000	0.043	0.013	0.056	0.125
Q3	0.006	0.000	0.048	0.000	0.089	0.000	0.054	0.021	0.075	0.219
Q4	0.006	0.000	0.027	0.000	0.085	0.000	0.092	0.038	0.130	0.248
Grand Total	**0.030**	**0.013**	**0.256**	**0.001**	**0.274**	**0.008**	**0.324**	**0.094**	**0.418**	**1.000**

Table 5: Proportion of 2005-2010 incidental catch of river herring by region, fleet and quarter.

	Bottom trawl				Gillnet		Paired MWT	Single MWT	Total MWT	Grand Total
	lg	med	sm	xlg	lg	sm	all	all		
Mid-Atlantic (SA >= 600)	**0.001**	**0.001**	**0.055**	**0.000**	**0.000**	**0.000**	**0.291**	**0.092**	**0.383**	**0.439**
Q1	0.000	0.000	0.017	0.000	0.000	0.000	0.265	0.082	0.347	0.365
Q2	0.000	0.000	0.010	0.000	0.000	0.000	0.017	0.008	0.025	0.036
Q3	0.000	0.000	0.020	0.000	0.000	0.000	0.000	0.001	0.002	0.022
Q4	0.000	0.000	0.009	0.000	0.000	0.000	0.008	0.000	0.008	0.017
New England (SA <= 500)	**0.004**	**0.000**	**0.182**	**0.000**	**0.000**	**0.000**	**0.266**	**0.109**	**0.374**	**0.561**
Q1	0.001	0.000	0.069	0.000	0.000	0.000	0.026	0.016	0.043	0.113
Q2	0.001	0.000	0.030	0.000	0.000	0.000	0.057	0.056	0.114	0.145
Q3	0.001	0.000	0.045	0.000	0.000	0.000	0.049	0.006	0.055	0.101
Q4	0.001	0.000	0.038	0.000	0.000	0.000	0.133	0.030	0.163	0.202
Grand Total	**0.005**	**0.001**	**0.237**	**0.000**	**0.000**	**0.000**	**0.556**	**0.200**	**0.757**	**1.000**

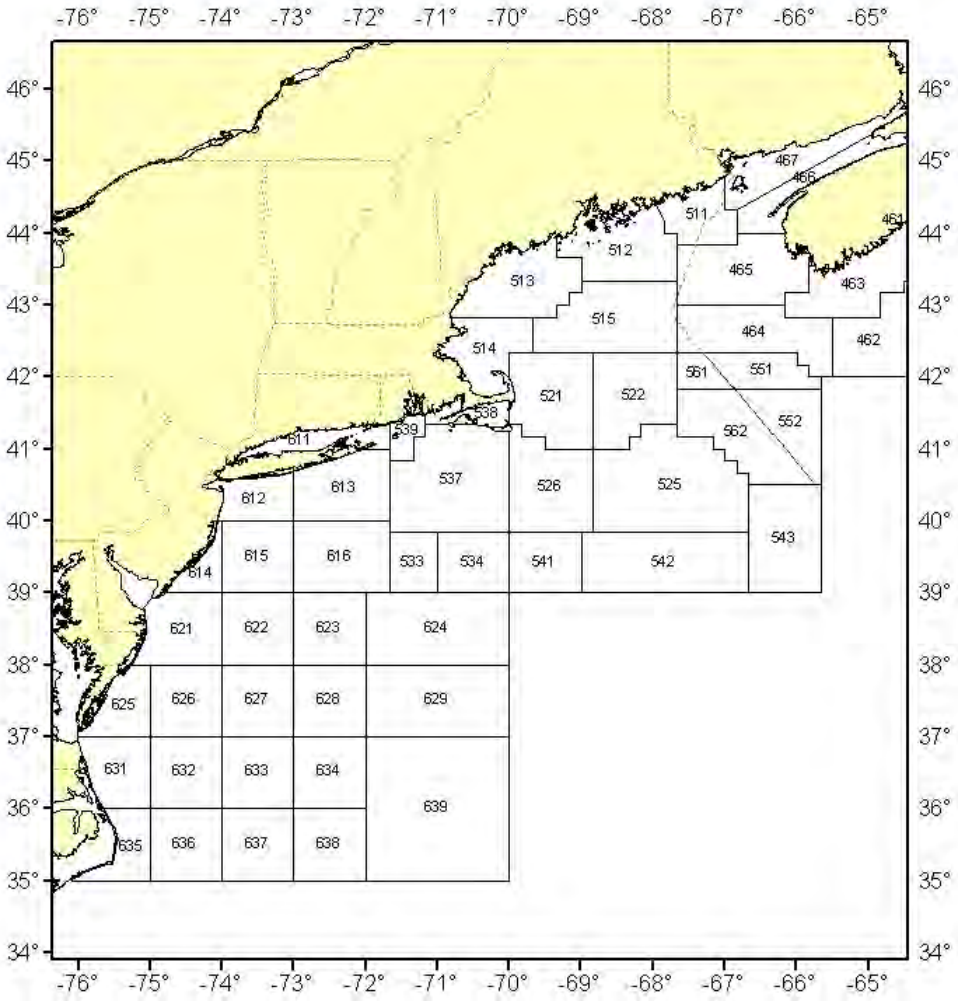


Figure 1: Statistical Areas used to define the fishing regions used in the incidental catch analysis. The Mid-Atlantic region included Statistical Areas greater than 600. The New England region included Statistical Areas 464 through 599.

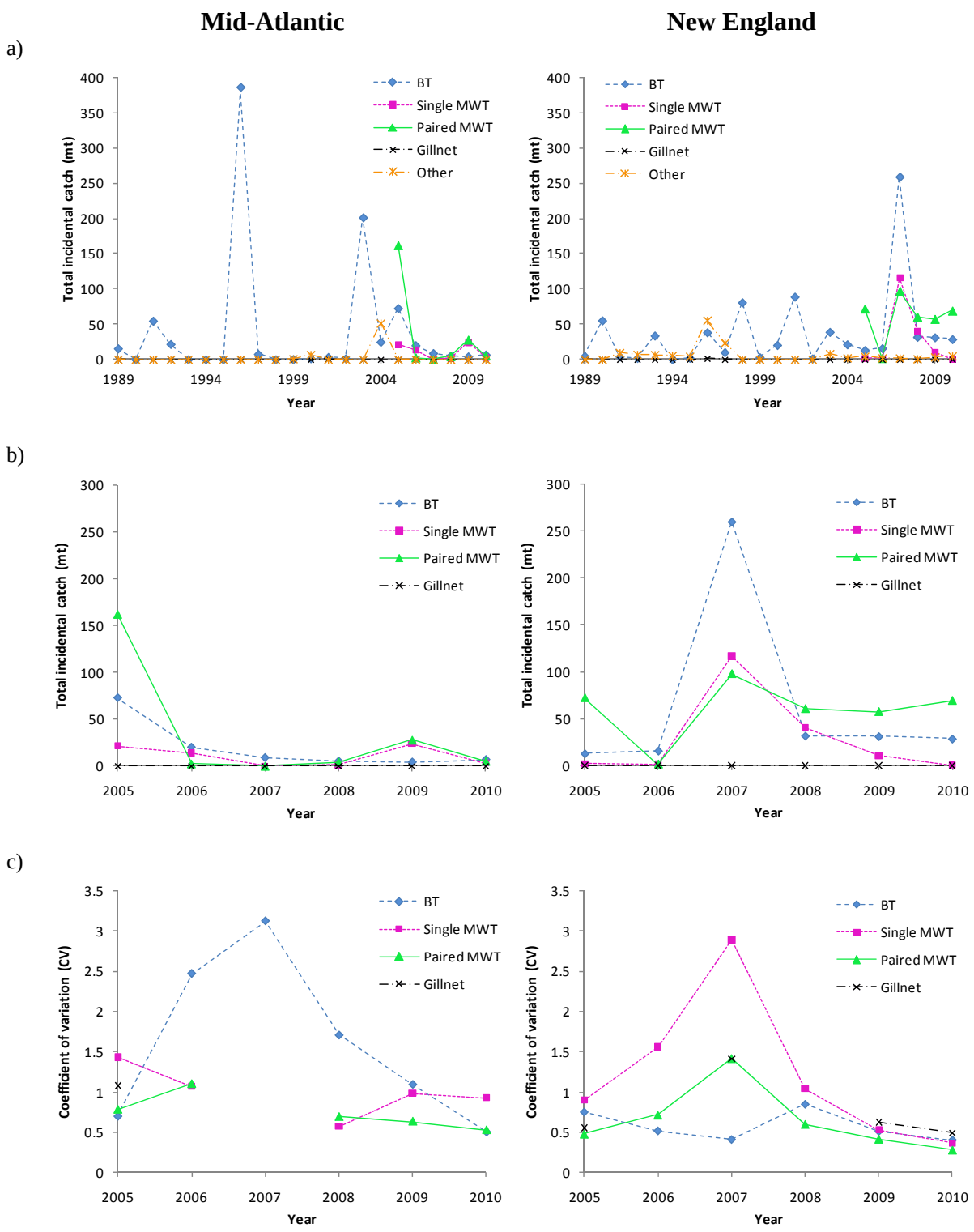


Figure 2: Alewife total annual incidental catch (mt) by region for the four gears with the largest catches from a) 1989 – 2010 and b) 2005 – 2010, and c) the corresponding estimates of precision. Midwater trawl estimates are only included beginning in 2005.

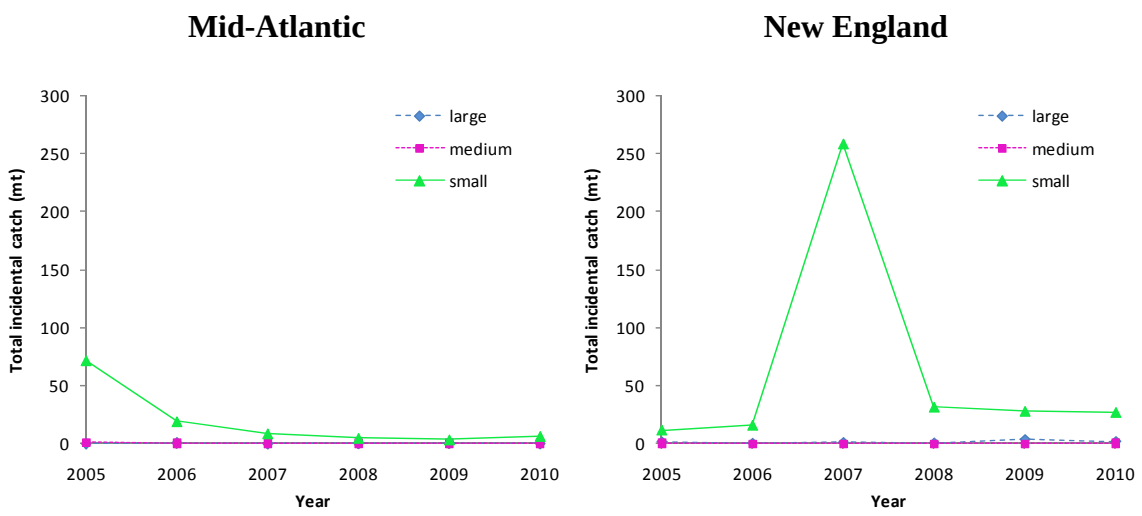


Figure 3: Alewife total incidental catch (mt) from 2005 – 2010 by region and bottom trawl mesh category.

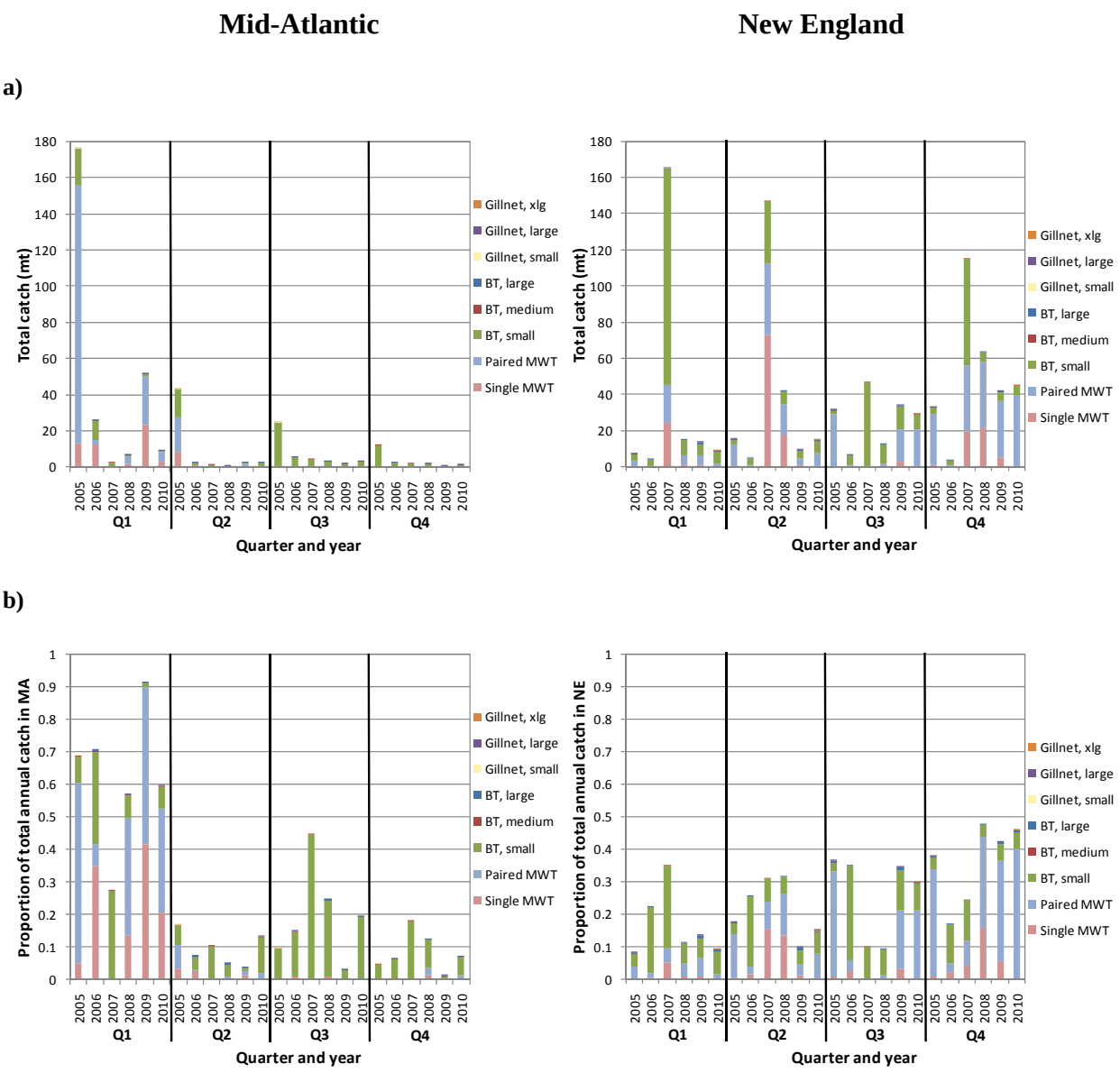


Figure 4: Alewife quarterly incidental catch (mt) by region and fleet (a) and the corresponding proportion of the total annual catch within each region and quarter (b).

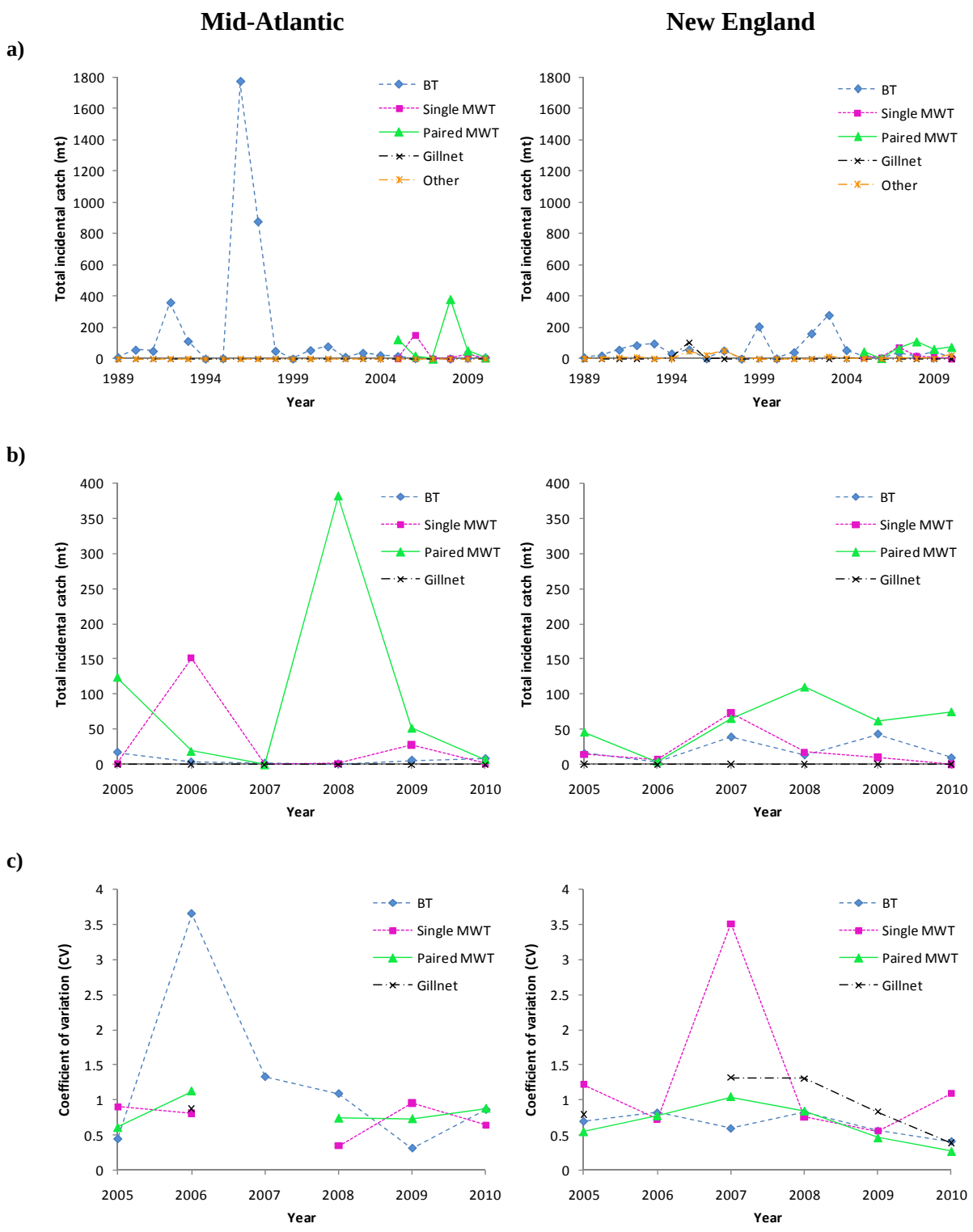


Figure 5: Blueback herring total annual incidental catch (mt) by region for the four gears with the largest catches from a) 1989 – 2010 and b) 2005 – 2010, and c) the corresponding estimates of precision. Midwater trawl estimates are only included beginning in 2005.

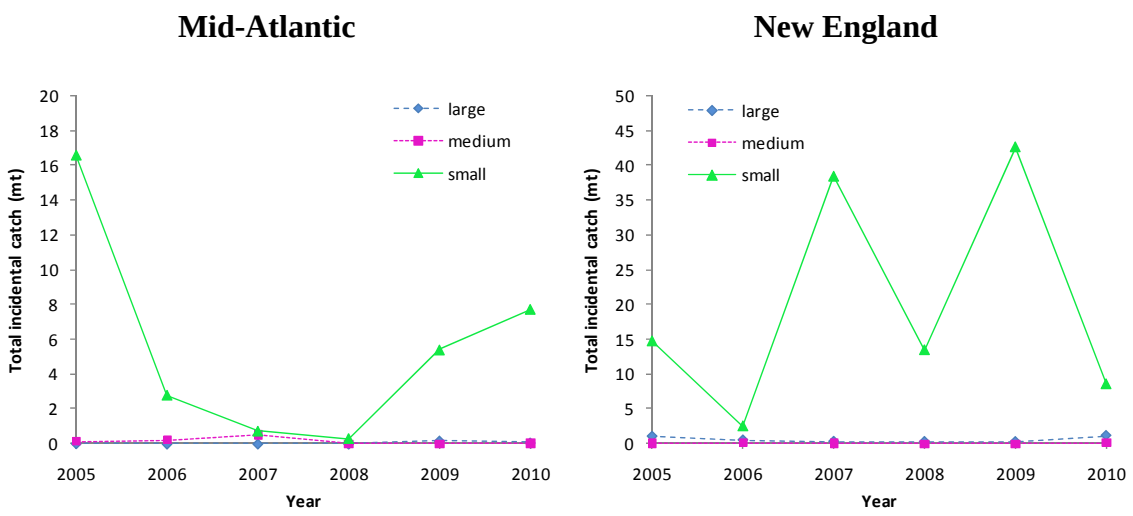


Figure 6: Blueback herring total incidental catch (mt) from 2005 – 2010 by region and bottom trawl mesh category.

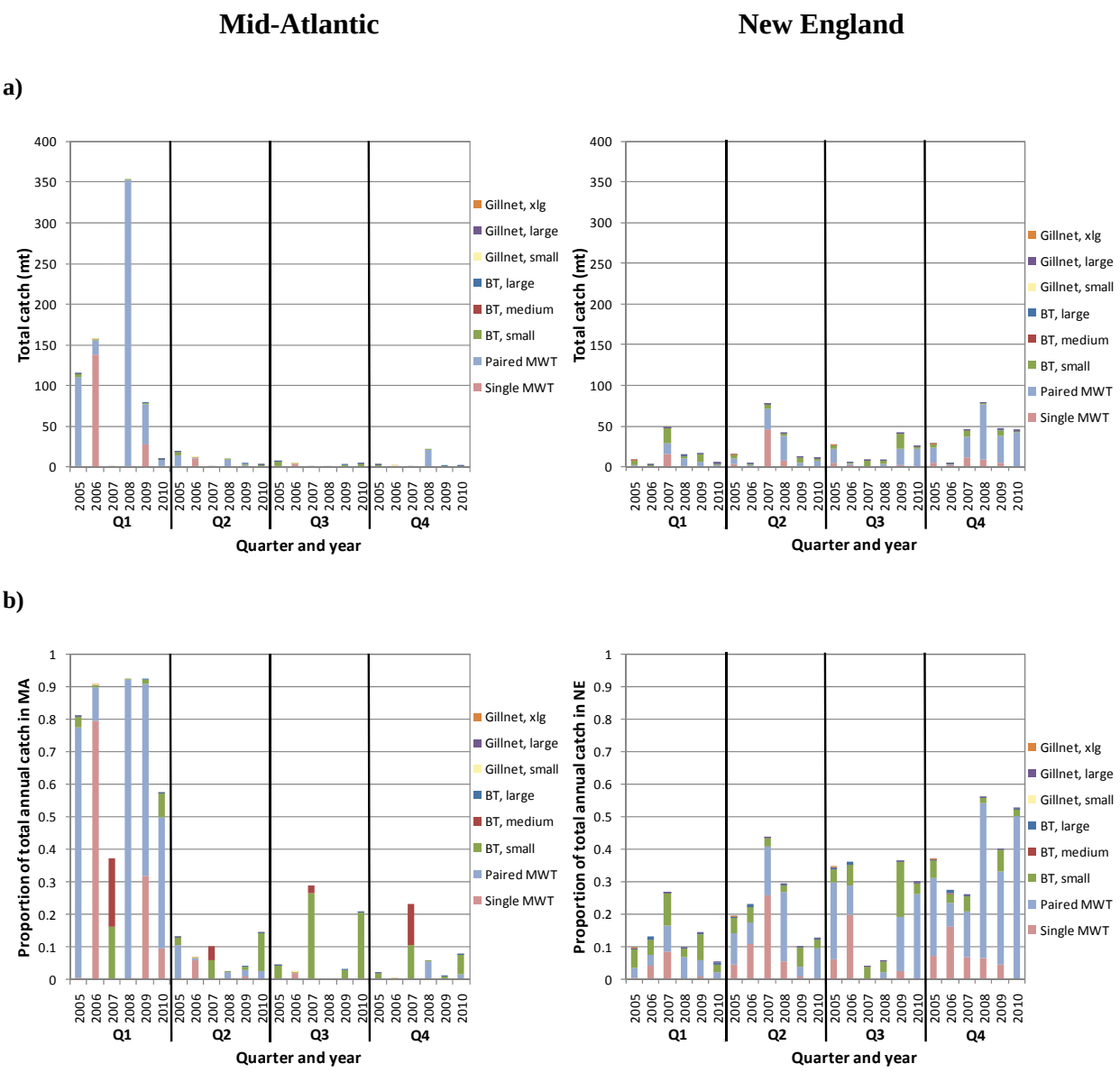


Figure 7: Blueback herring incidental catch (mt) by region and fleet (a) and the corresponding proportion of the total annual catch within each region and quarter (b).

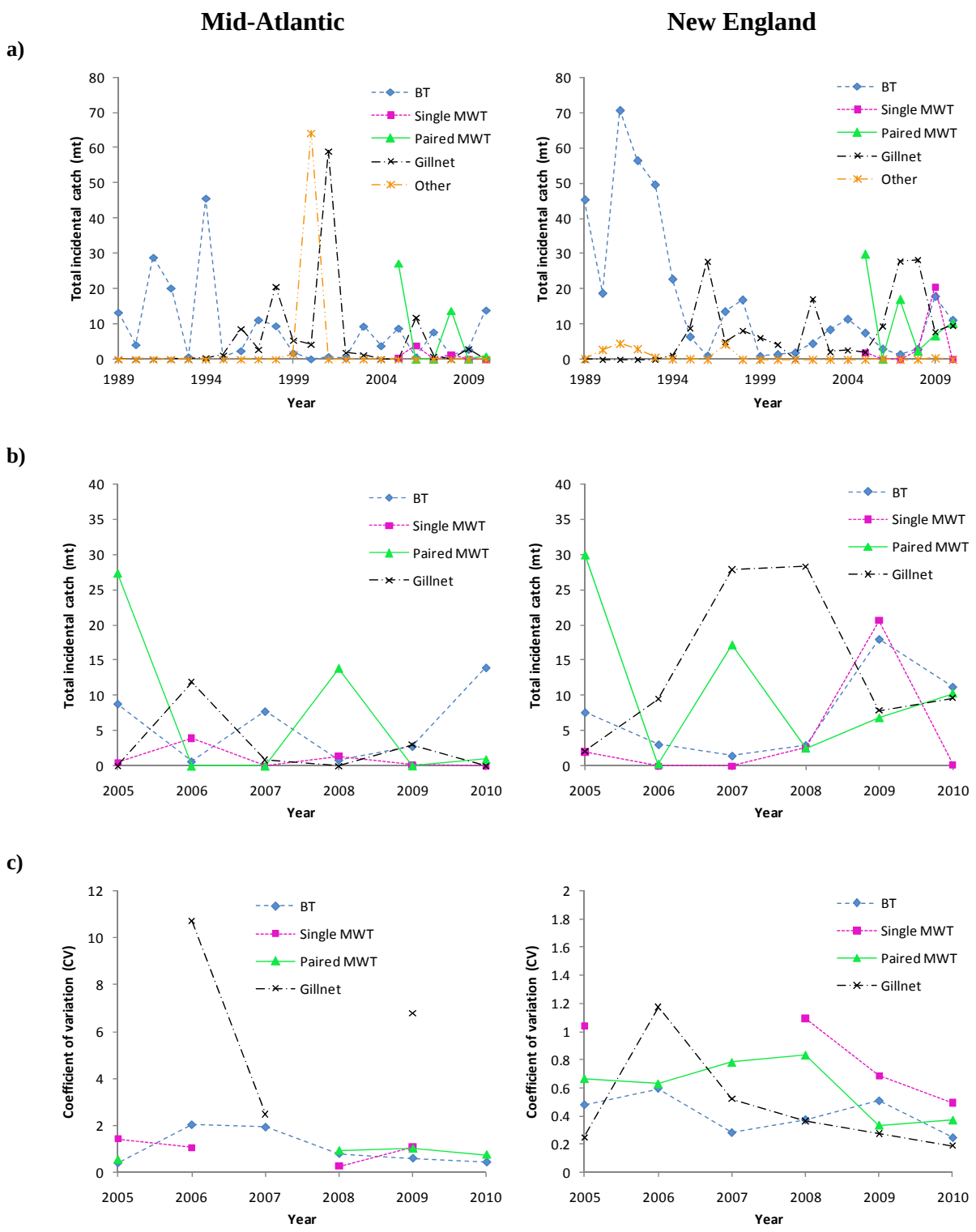


Figure 8: American shad total annual incidental catch (mt) by region for the four gears with the largest catches from a) 1989 – 2010 and b) 2005 – 2010, and c) the corresponding estimates of precision. Midwater trawl estimates are only included beginning in 2005.

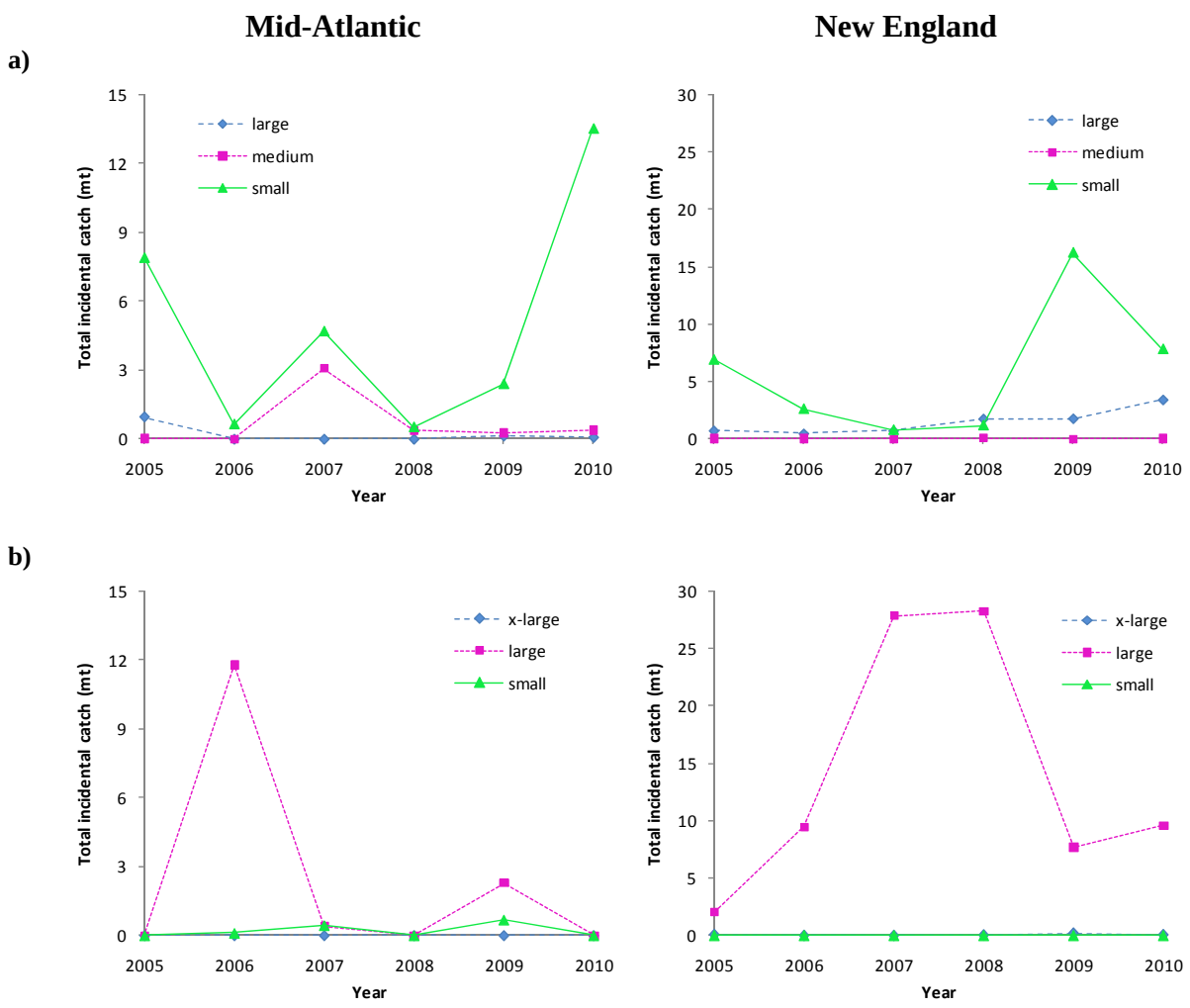


Figure 9: American shad total incidental catch (mt) from 2005 – 2010 by region and mesh category for a) bottom trawl and b) gillnet fleets.

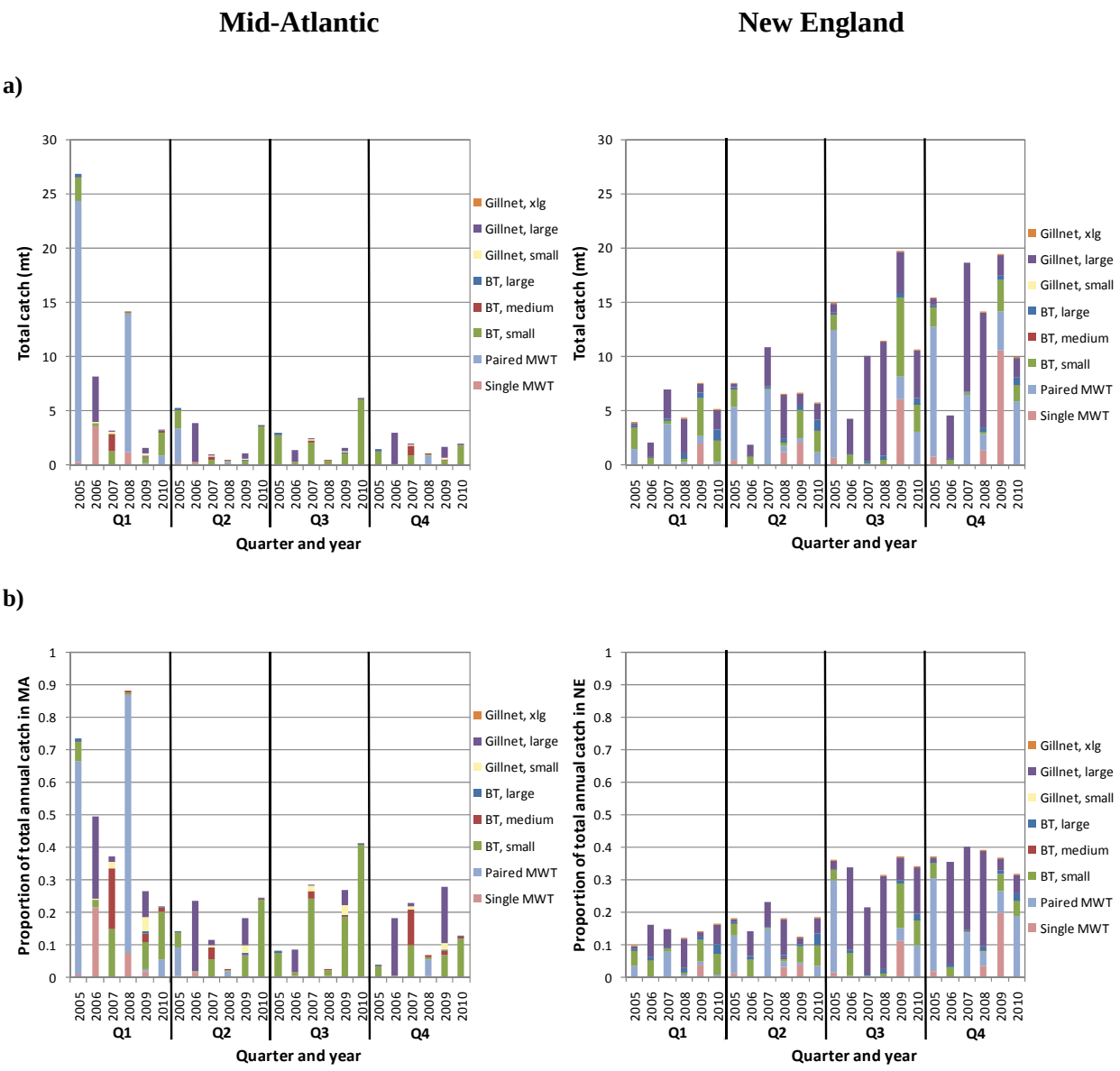


Figure 10: American shad quarterly incidental catch (mt) by region and fleet (a) and the corresponding proportion of the total annual catch within each region and quarter (b).

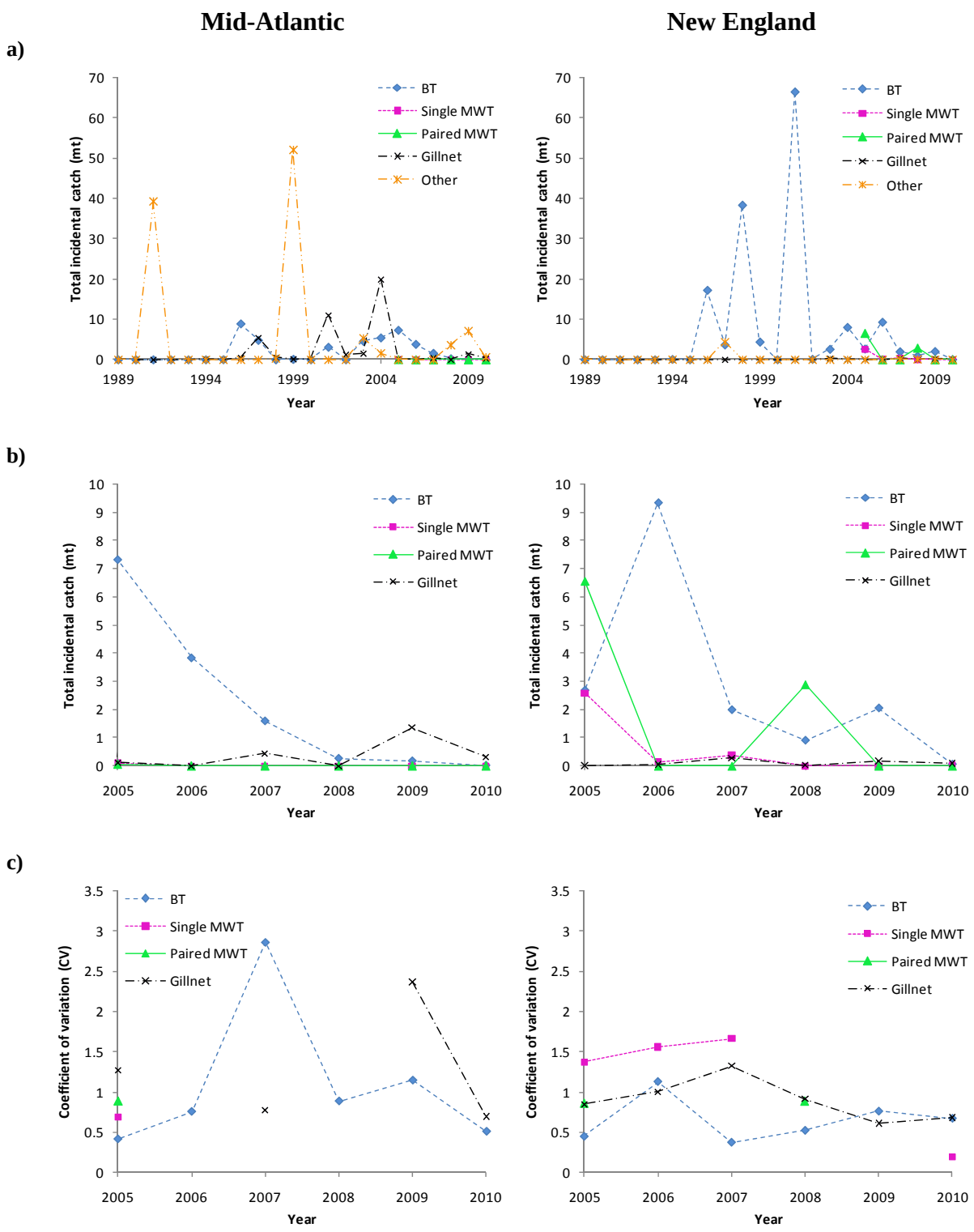


Figure 11: Hickory shad total annual incidental catch (mt) by region for the four gears with the largest catches from a) 1989 – 2010 and b) 2005 – 2010, and c) the corresponding estimates of precision. Midwater trawl estimates are only included beginning in 2005.

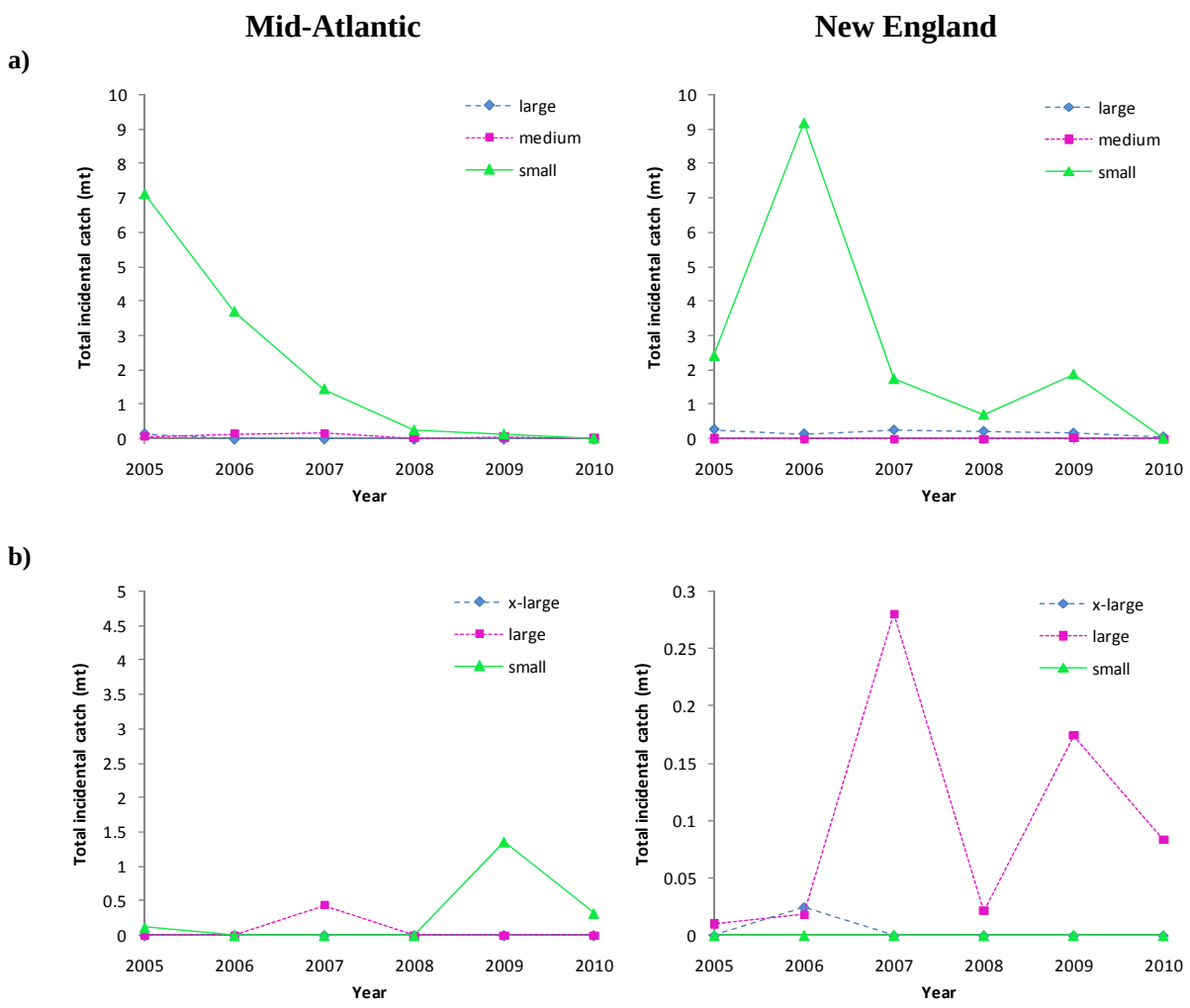


Figure 12: Hickory shad total incidental catch (mt) from 2005 – 2010 by region and mesh category for a) bottom trawl and b) gillnet fleets.

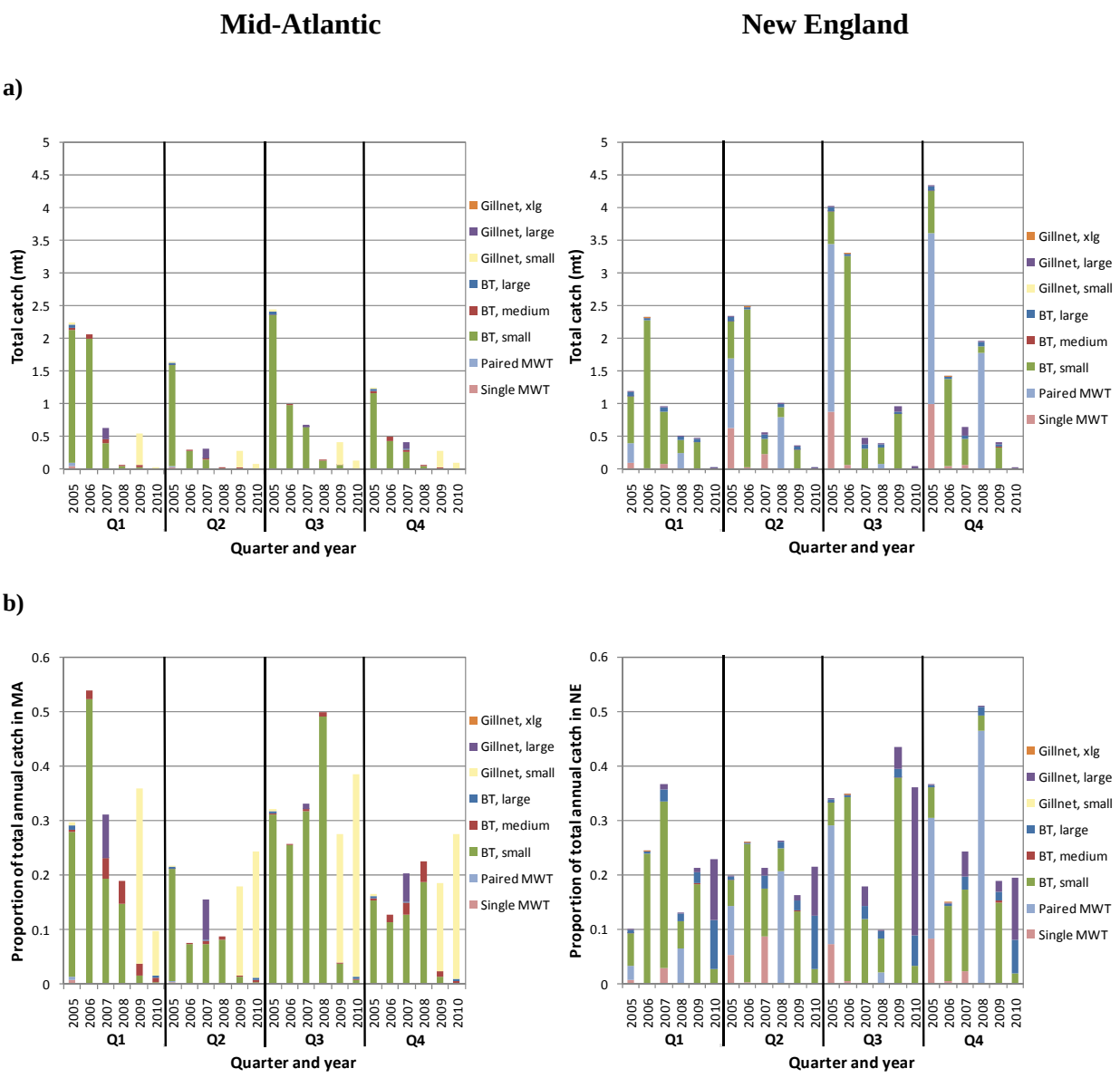


Figure 13: Hickory shad quarterly incidental catch (mt) by region and fleet (a) and the corresponding proportion of the total annual catch within each region and quarter (b).

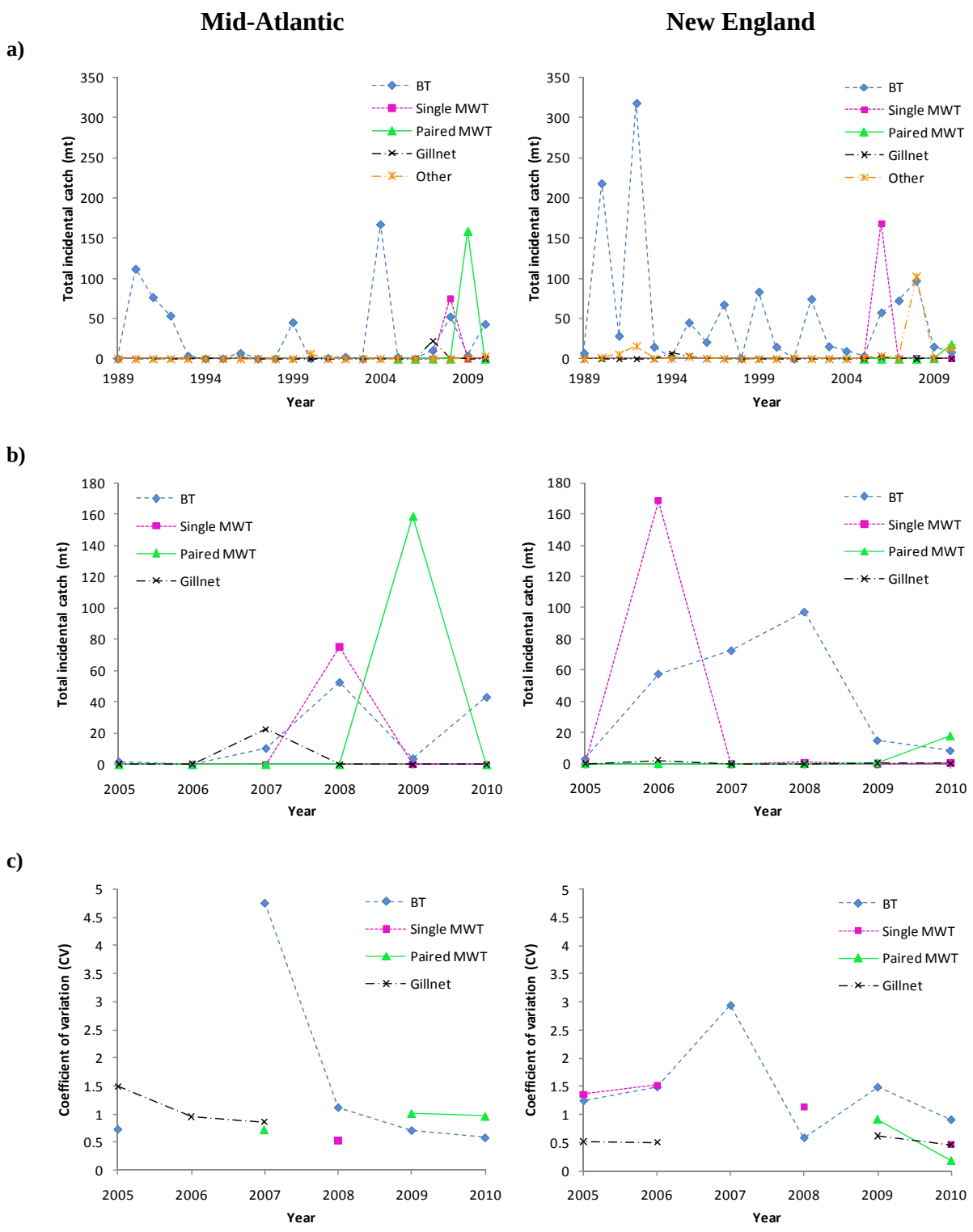


Figure 14: Unknown herring total annual incidental catch (mt) by region for the four gears with the largest catches from a) 1989 – 2010 and b) 2005 – 2010, and c) the corresponding estimates of precision. Midwater trawl estimates are only included beginning in 2005.

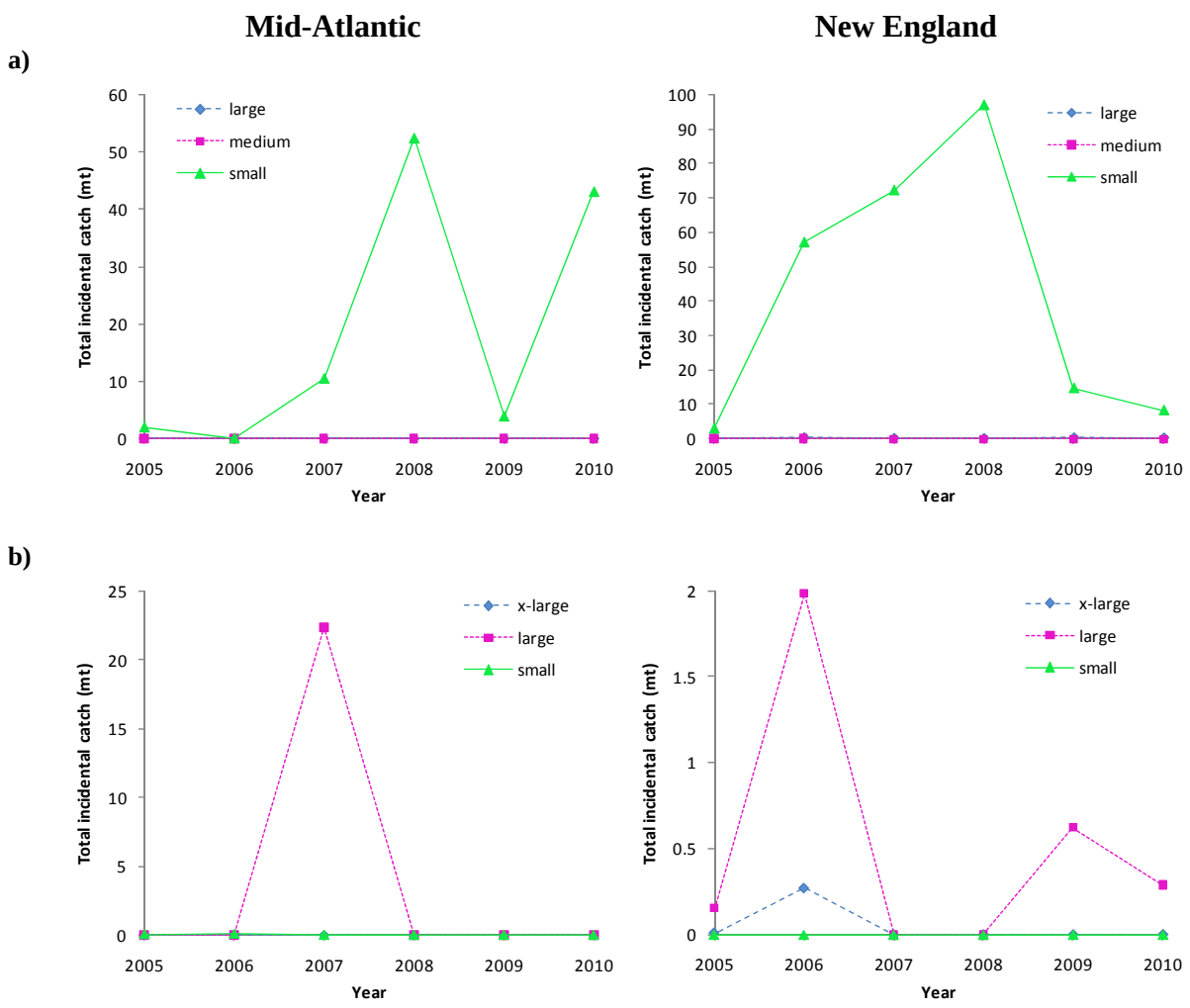


Figure 15: Unknown herring total incidental catch (mt) from 2005 – 2010 by region and mesh category for a) bottom trawl and b) gillnet fleets.

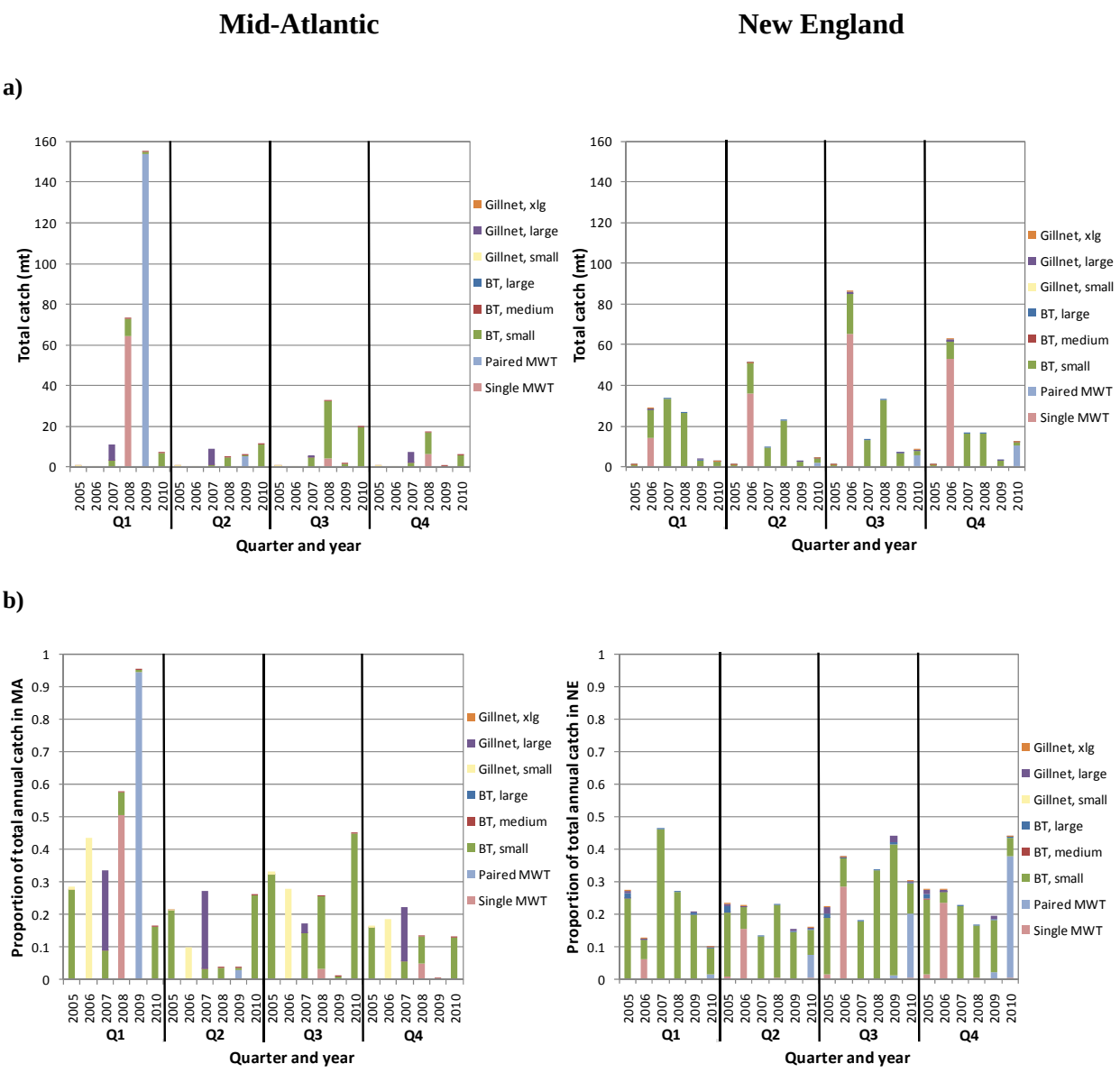


Figure 16: Unknown herring quarterly incidental catch (mt) by region and fleet (a) and the corresponding proportion of the total annual catch within each region and quarter (b).

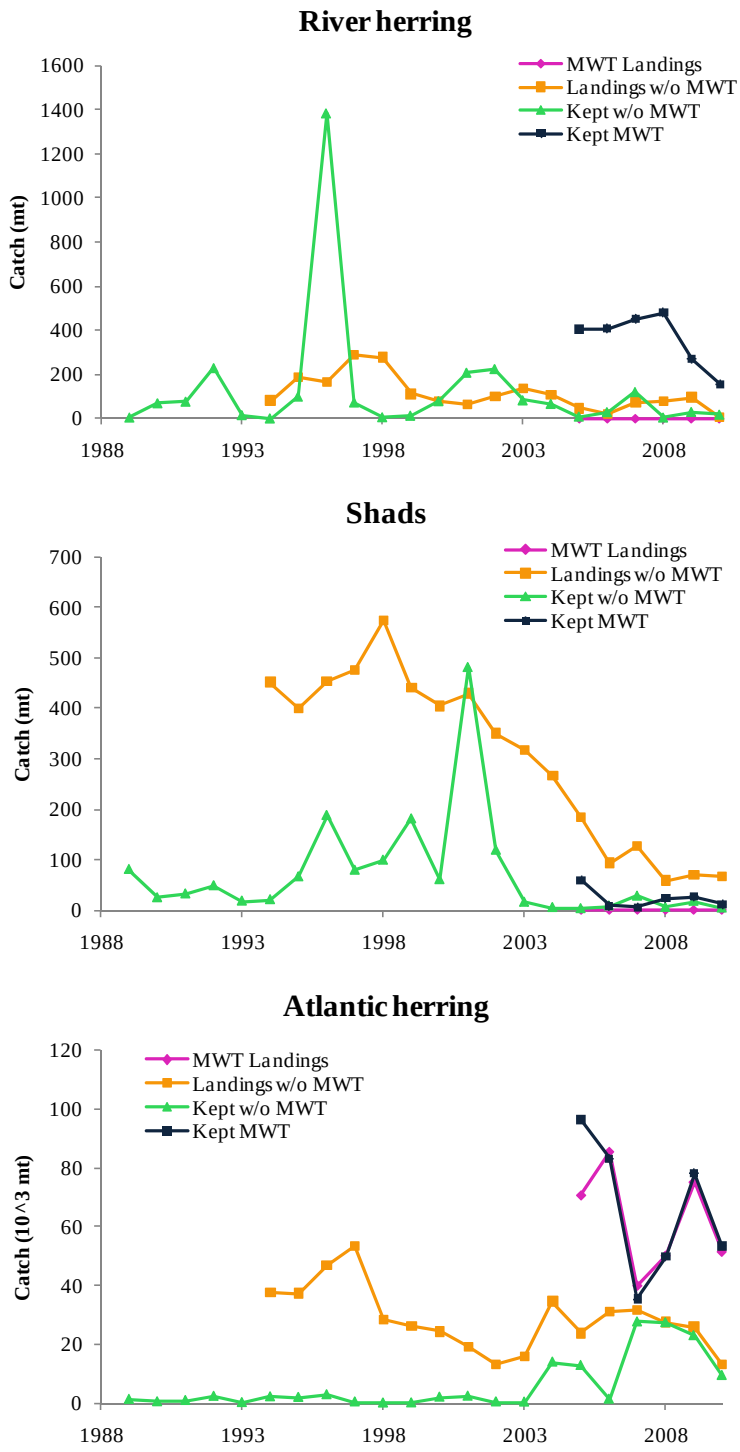
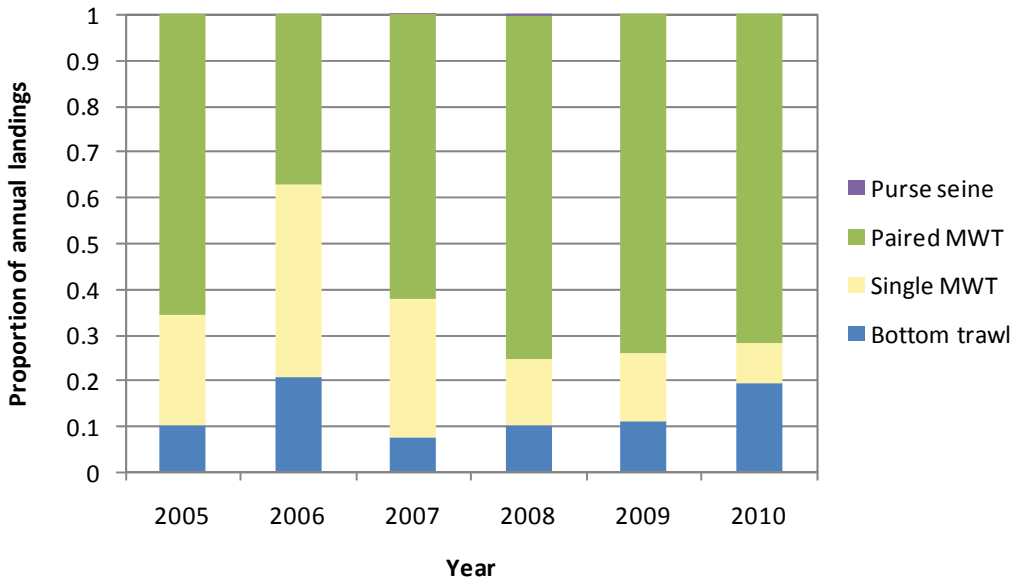


Figure 17: Comparison of landings obtained from the dealer database to the amount kept, quantified as the difference between total incidental catch and discards, for river herring (alewife and blueback herring), shad species (hickory and American shad) and Atlantic herring. Midwater trawl estimates are only included beginning in 2005. This validation exercise was conducted in a preliminary run where gear was not split into mesh categories.

a)



b)

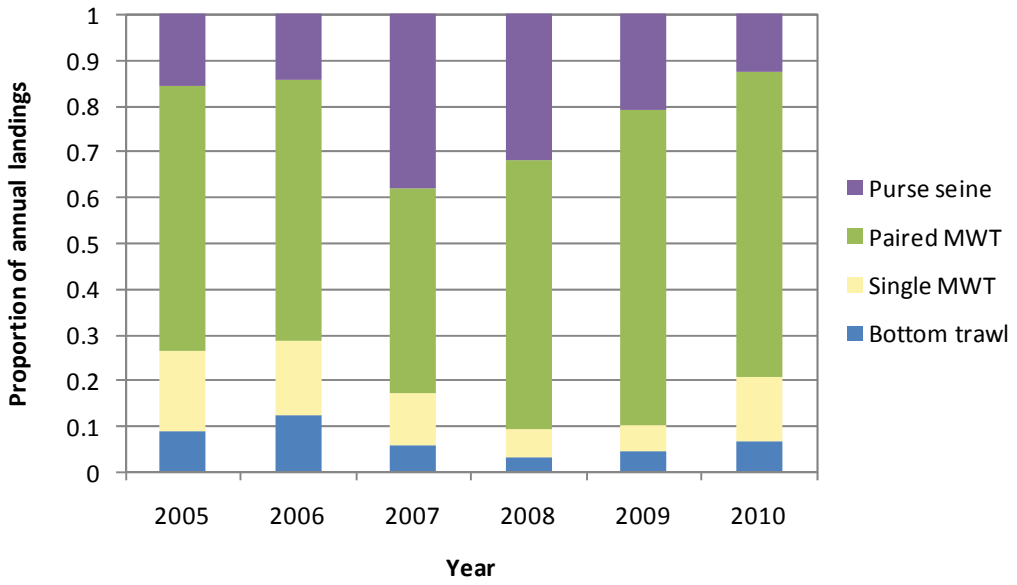
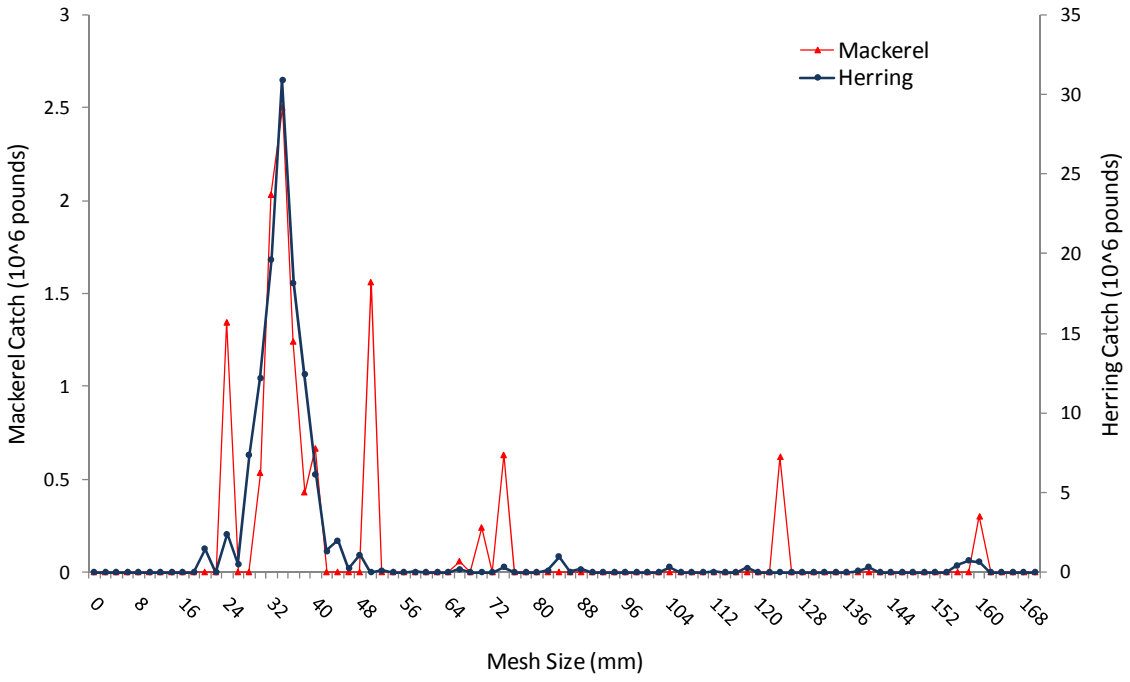


Figure 18: Distribution of a) mackerel and b) herring landings across gear from 2005 - 2010. Gears included in the analysis were purse seine, paired midwater trawls, single midwater trawls and bottom trawls. It was assumed that these gears represented the majority of both mackerel and herring landings.

a)



b)

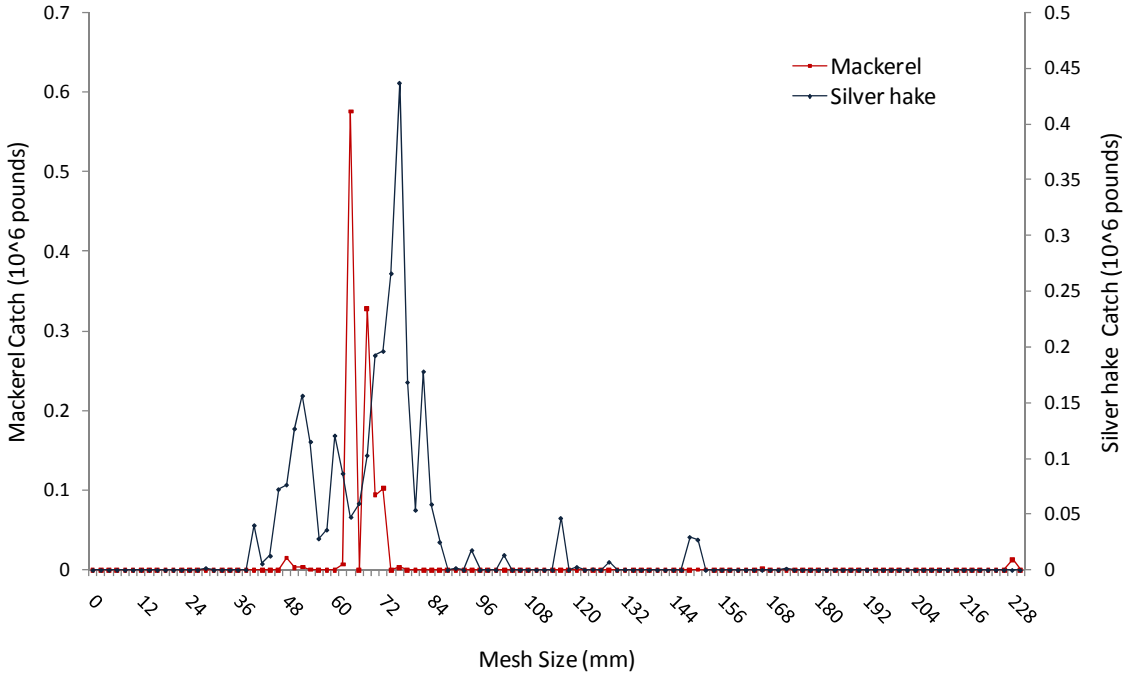
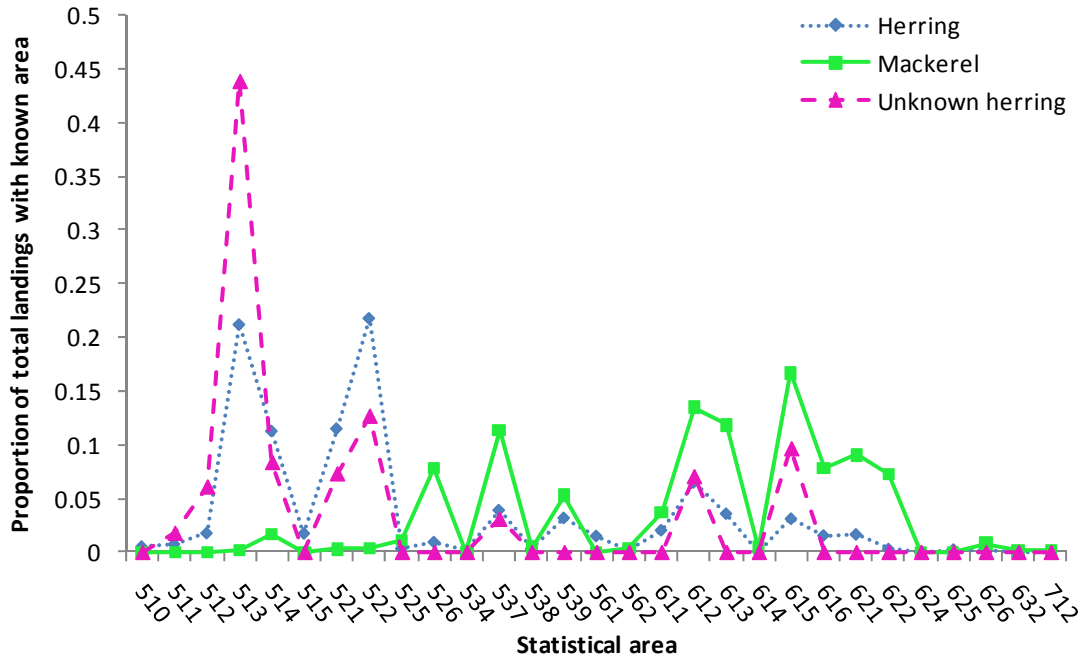


Figure 19: Mackerel and herring midwater trawl landings (a) and mackerel and silver hake bottom trawl landings (b) by mesh size from 2005 – 2010.

a)



b)

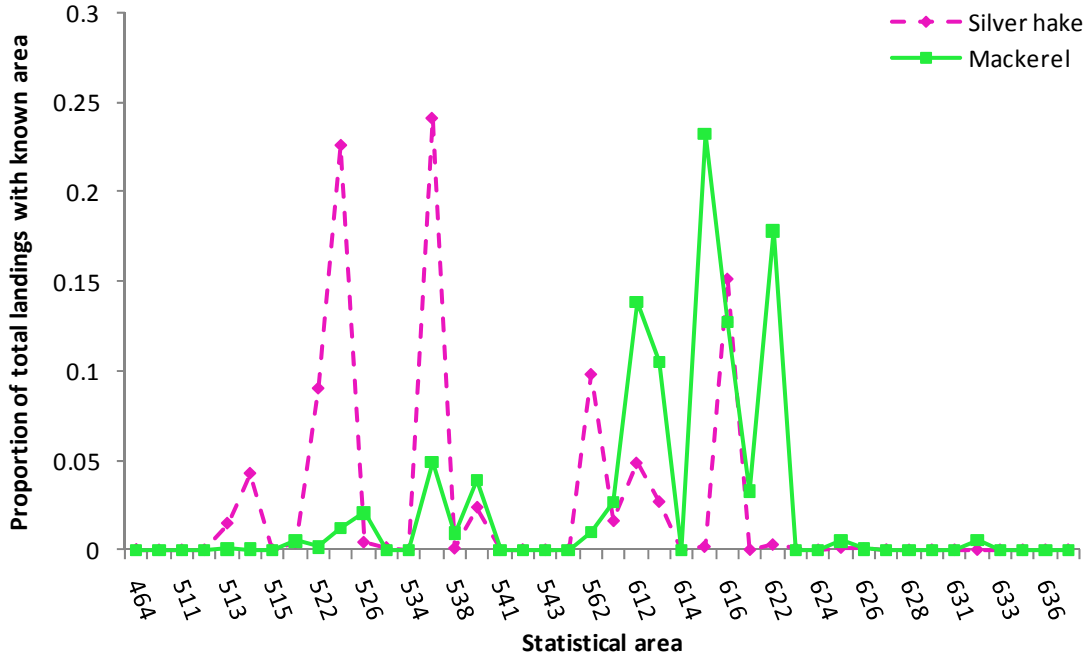


Figure 20: Proportion of species-specific midwater trawl (a) and bottom trawl (b) landings by statistical area from 2005 - 2010.

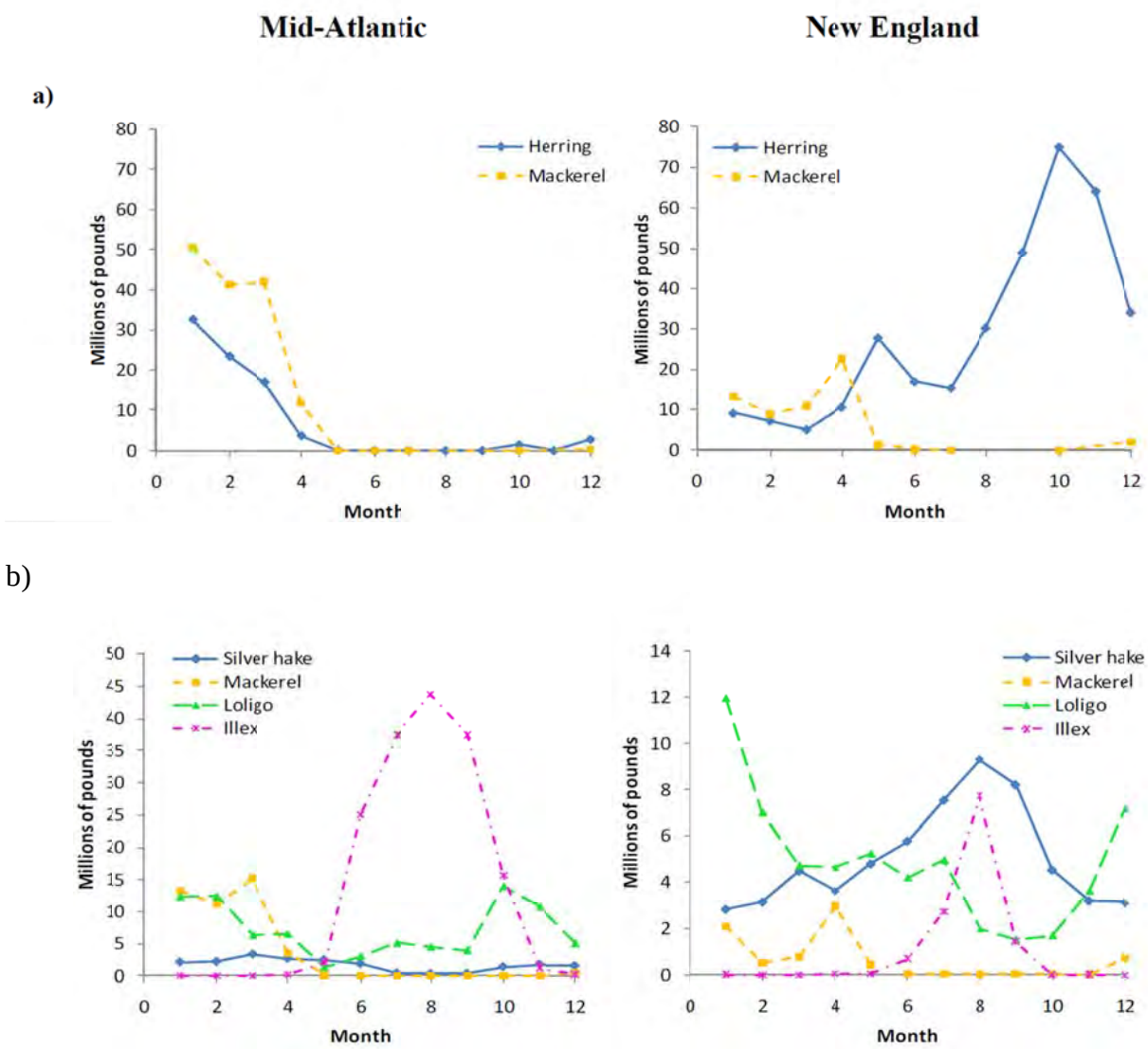
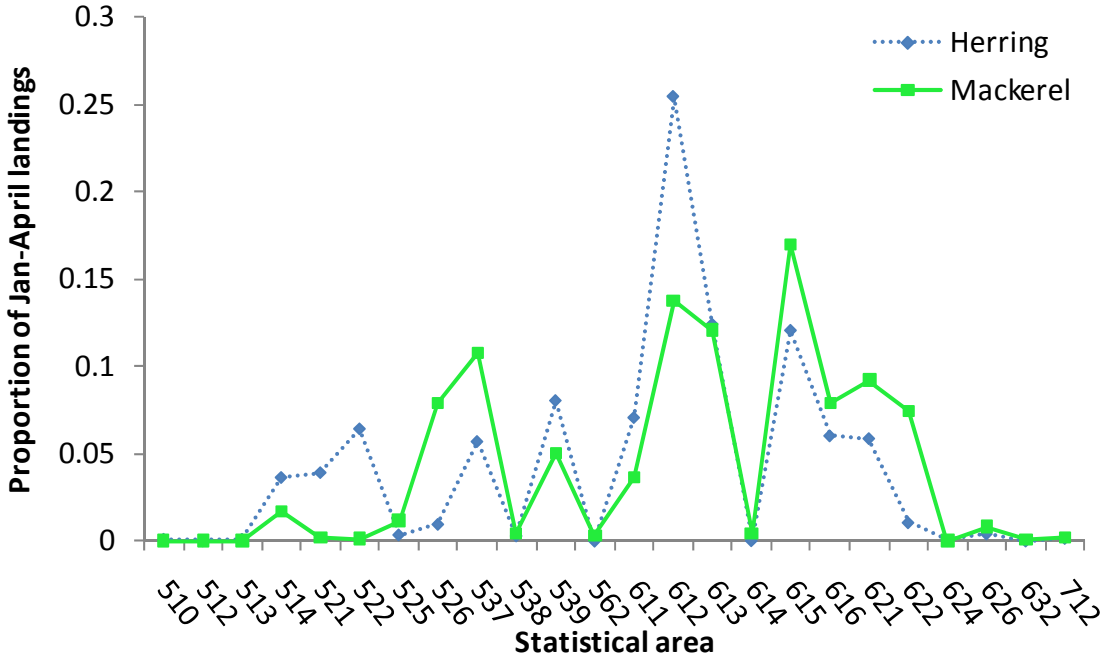


Figure 21: Species-specific midwater trawl (a) and bottom trawl (b) landings (millions of pounds) by month and region from 2005 - 2010.

a)



b)

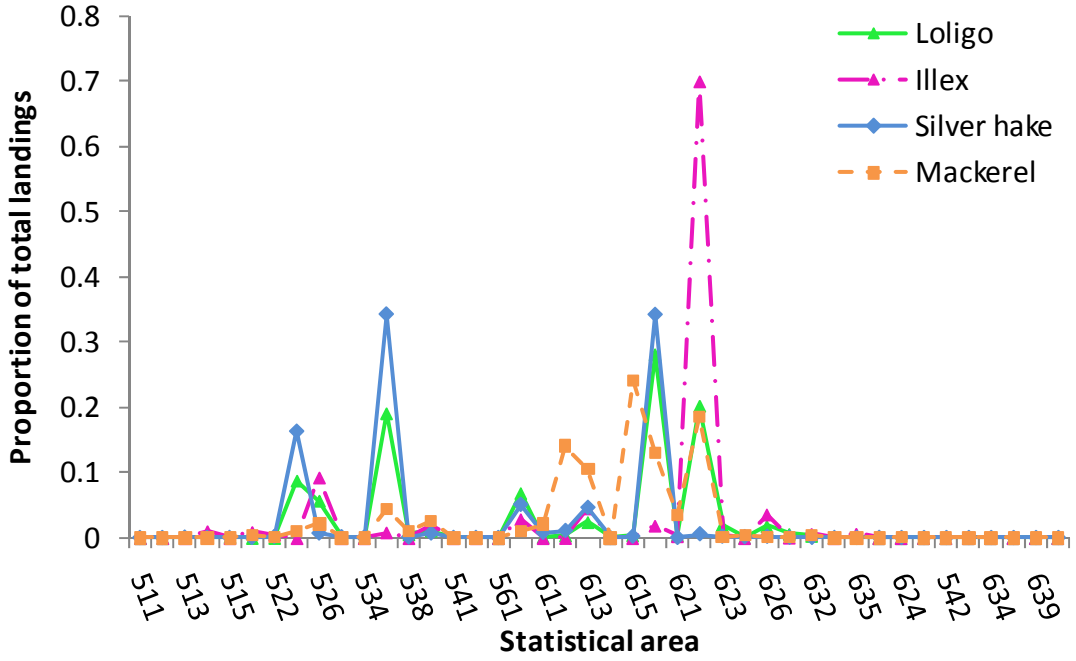


Figure 22: Proportion of January – April species-specific midwater trawl (a) and bottom trawl (b) landings by statistical area from 2005 - 2010.

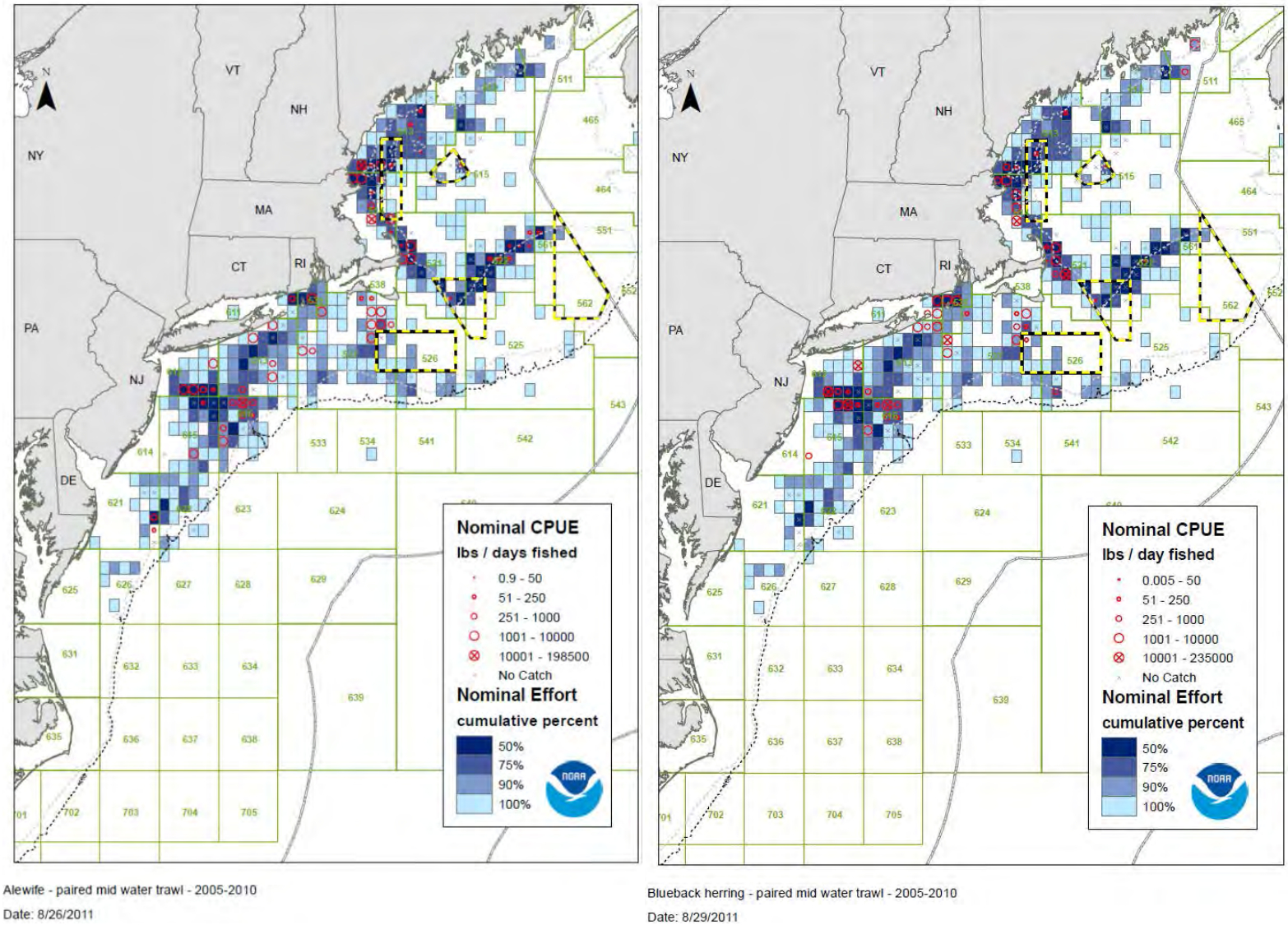
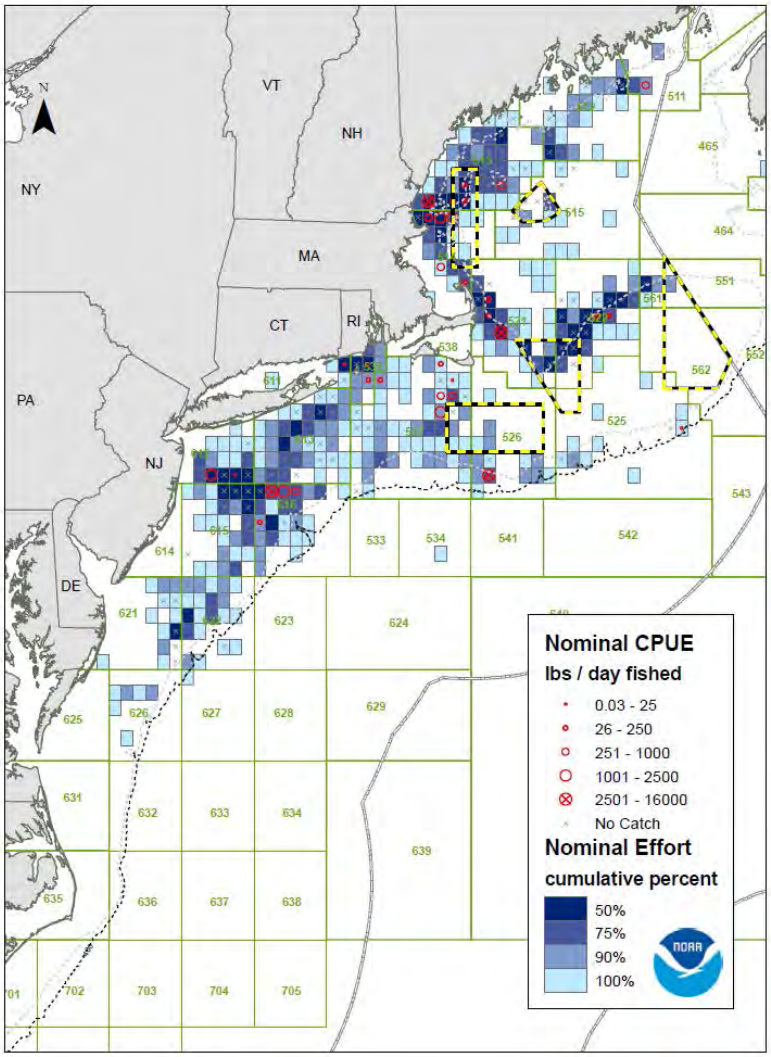
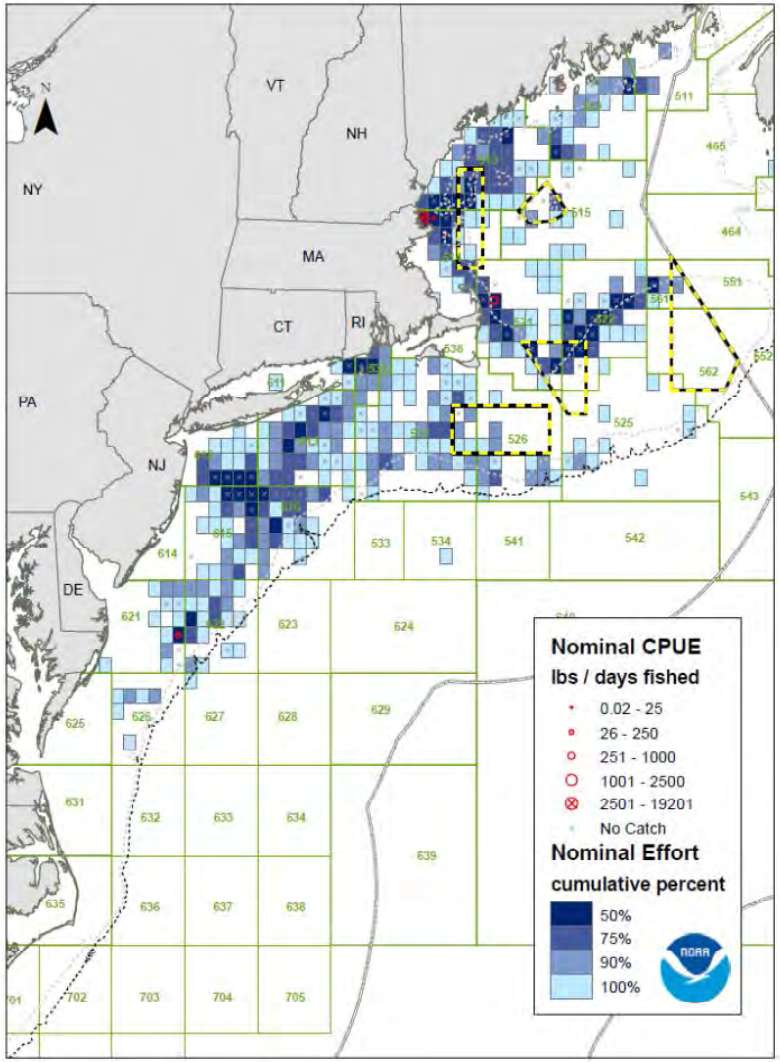


Figure 23. Spatial distribution of nominal effort (days fished from Vessel Trip Reports) for the paired midwater trawl fleet and the fleet's incidental catch rates (kept+discarded weight/days fished from observed NEFOP trips) of alewife (left) and blueback (right), by ten-minute square, during 2005-2010.



American shad - paired mid water trawl - 2005-2010

Date: 8/26/2011



Hickory shad - paired mid water trawl - 2005-2010

Date: 8/29/2011

Figure 24. Spatial distribution of nominal effort (days fished from Vessel Trip Reports) for the paired midwater trawl fleet and the fleet's incidental catch rates (kept+discarded weight/days fished from observed NEFOP trips) of American shad (left) and hickory shad (right), by ten-minute square, during 2005-2010.

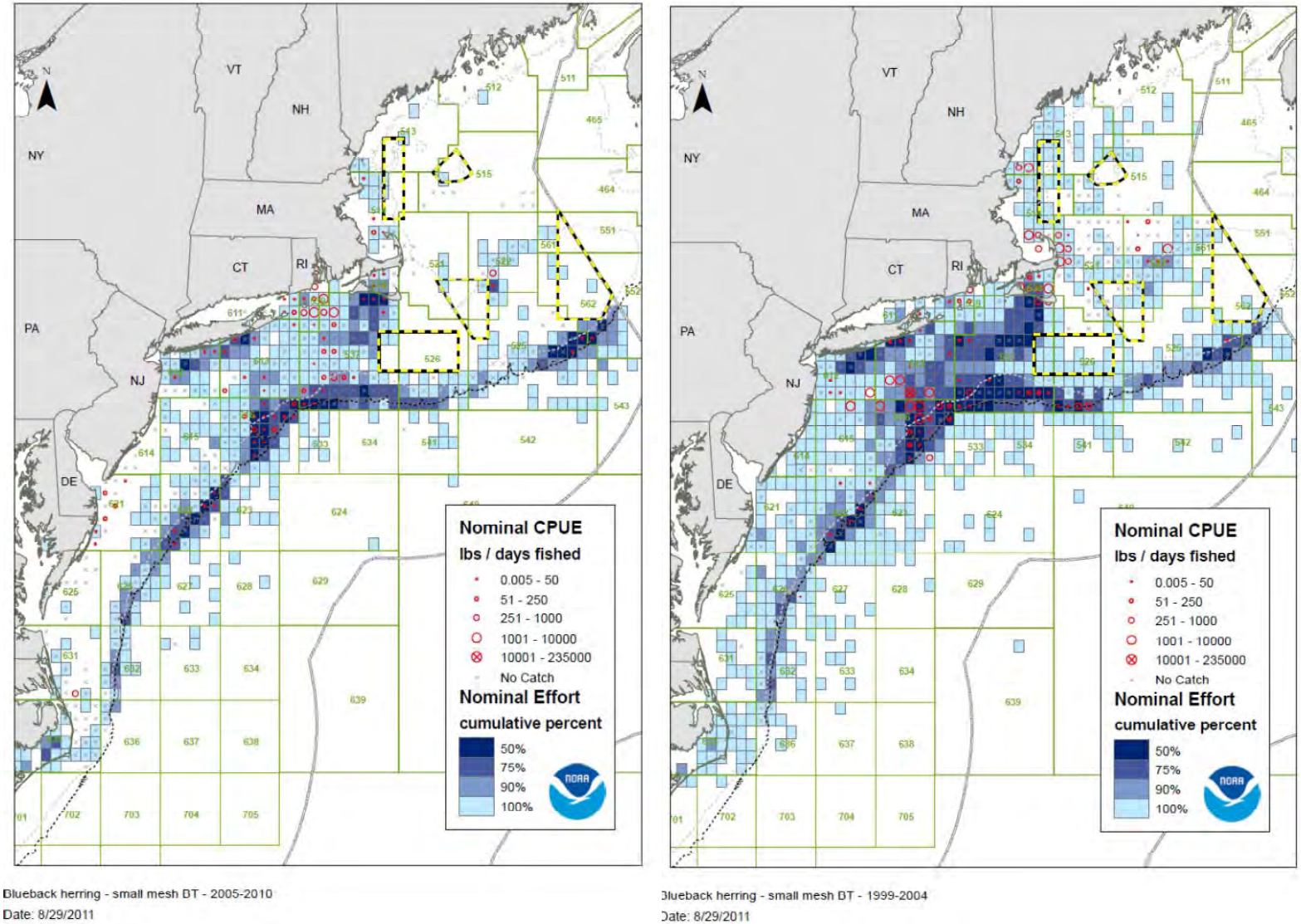
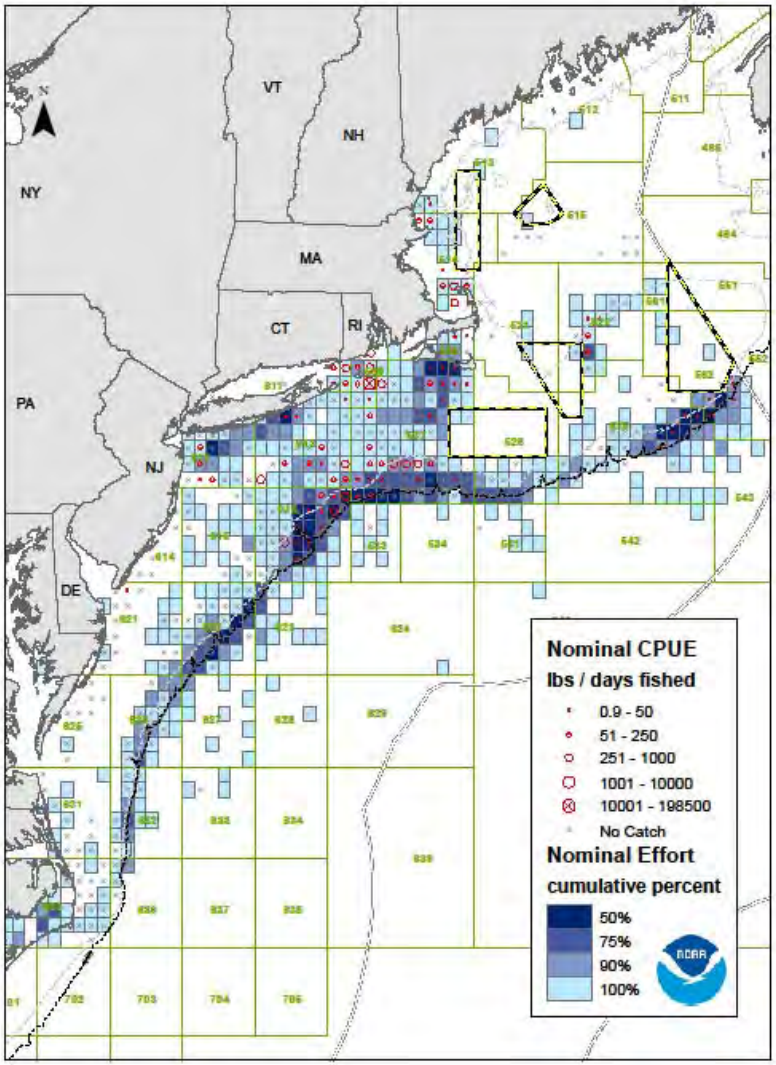
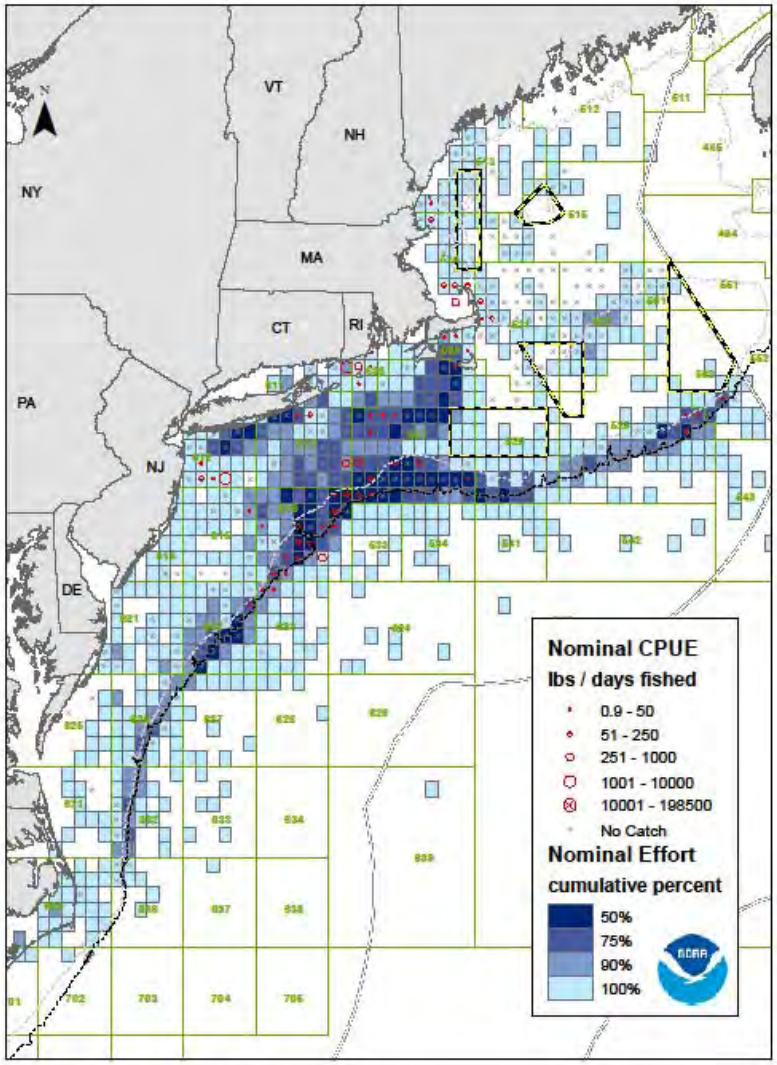


Figure 25. Spatial distribution of nominal effort (days fished from Vessel Trip Reports) for the small mesh (codend mesh ≤ 3.5 in.) bottom trawl fleet and the fleet's incidental catch rates (kept+discarded weight/days fished from observed NEFOP trips) of blueback herring, by ten-minute square, during 2005-2010 and 1999-2004.

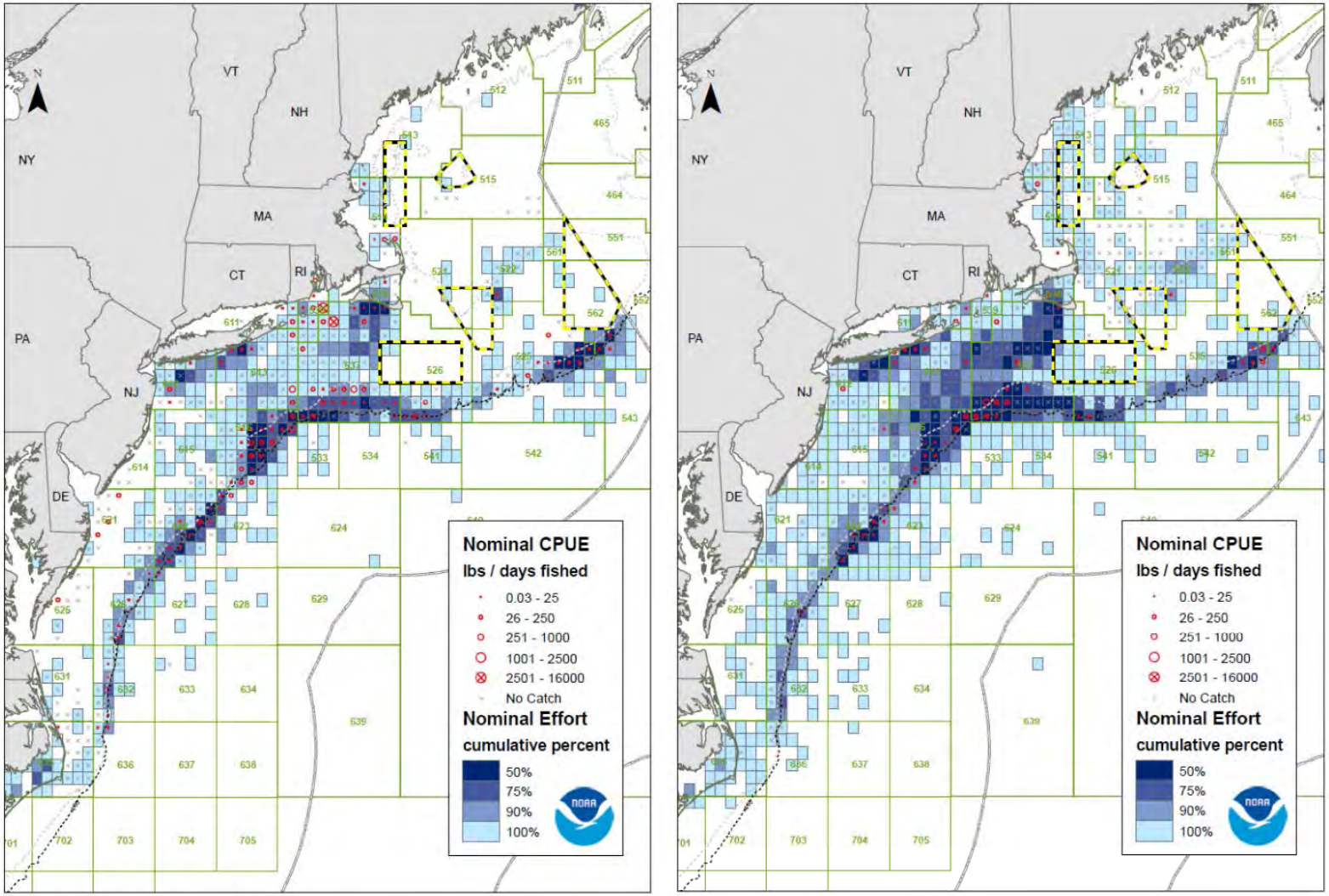


Alewife - small mesh BT - 2005-2010
Date: 8/26/2011



Alewife - small mesh BT - 1999-2004
Date: 8/26/2011

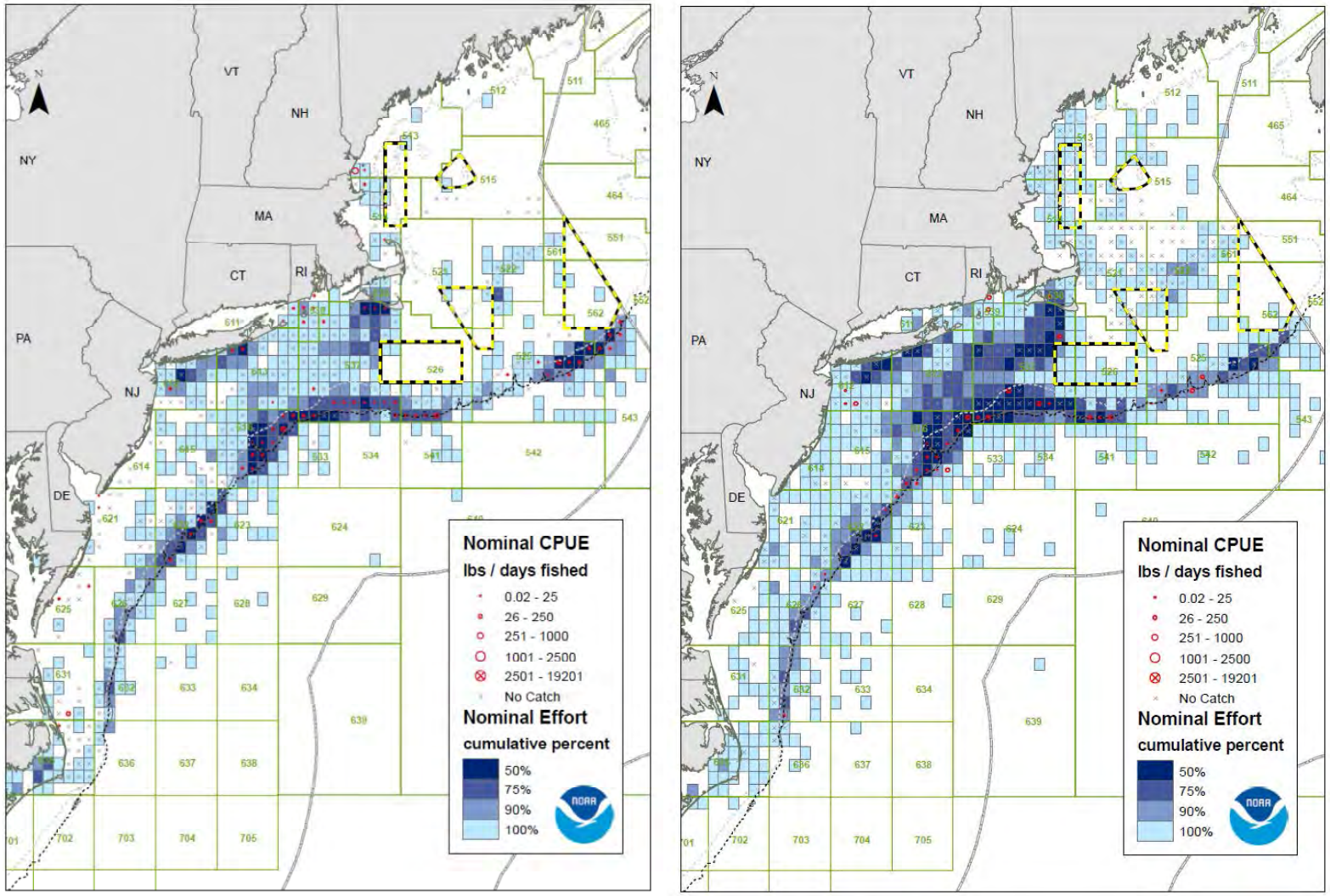
Figure 26. Spatial distribution of nominal effort (days fished from Vessel Trip Reports) for the small mesh (codend mesh ≤ 3.5 in.) bottom trawl fleet and the fleet's incidental catch rates (kept+discarded weight/days fished from observed NEFOP trips) of alewife, by ten-minute square, during 2005-2010 and 1999-2004.



American shad - small mesh BT - 2005-2010
Date: 8/26/2011

American shad - small mesh BT - 1999-2004
Date: 8/26/2011

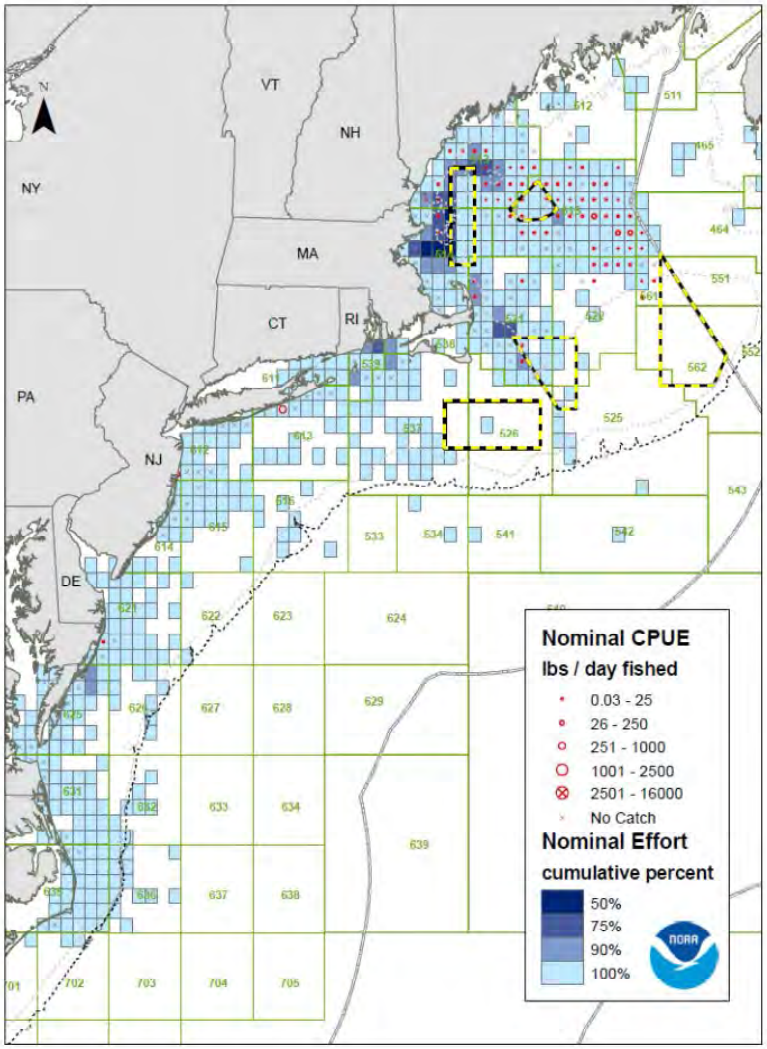
Figure 27. Spatial distribution of nominal effort (days fished from Vessel Trip Reports) for the small mesh (codend mesh ≤ 3.5 in.) bottom trawl fleet and the fleet's incidental catch rates (kept+discarded weight/days fished from observed NEFOP trips) of American shad, by ten-minute square, during 2005-2010 and 1999-2004.



Hickory shad - small mesh BT - 2005-2010
Date: 8/29/2011

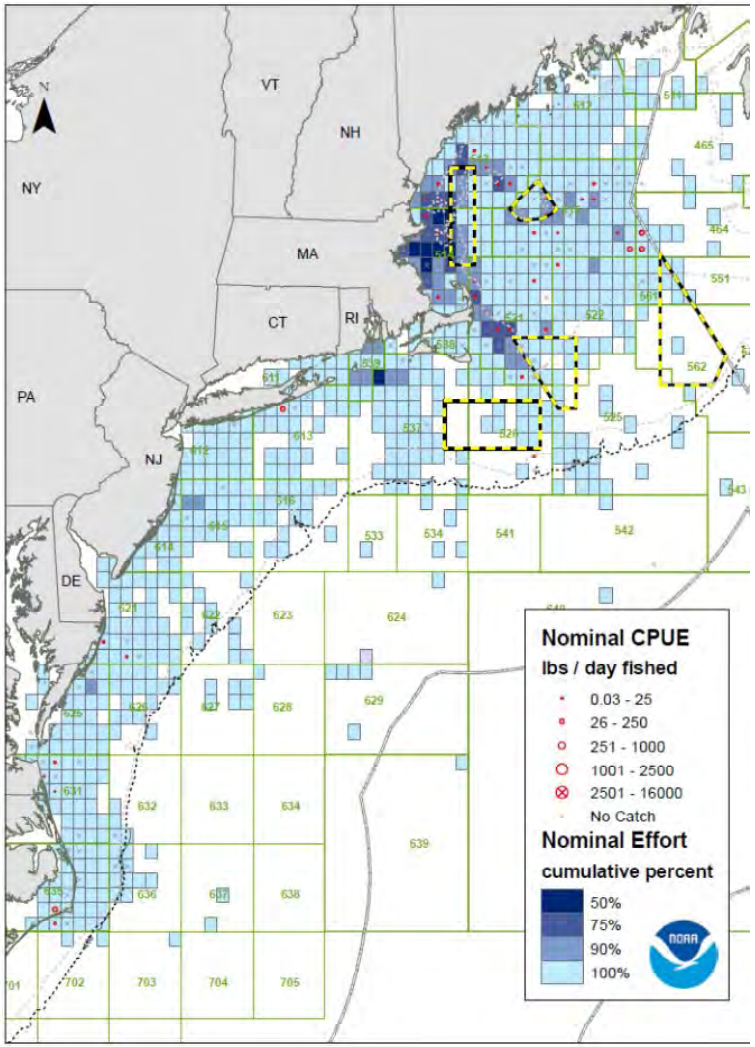
Hickory shad - small mesh BT - 1999-2004
Date: 8/29/2011

Figure 28. Spatial distribution of nominal effort (days fished from Vessel Trip Reports) for the small mesh (codend mesh ≤ 3.5 in.) bottom trawl fleet and the fleet's incidental catch rates (kept+discarded weight/days fished from observed NEFOP trips) of hickory shad, by ten-minute square, during 2005-2010 and 1999-2004.



American shad - large mesh gillnet - 2005-2010

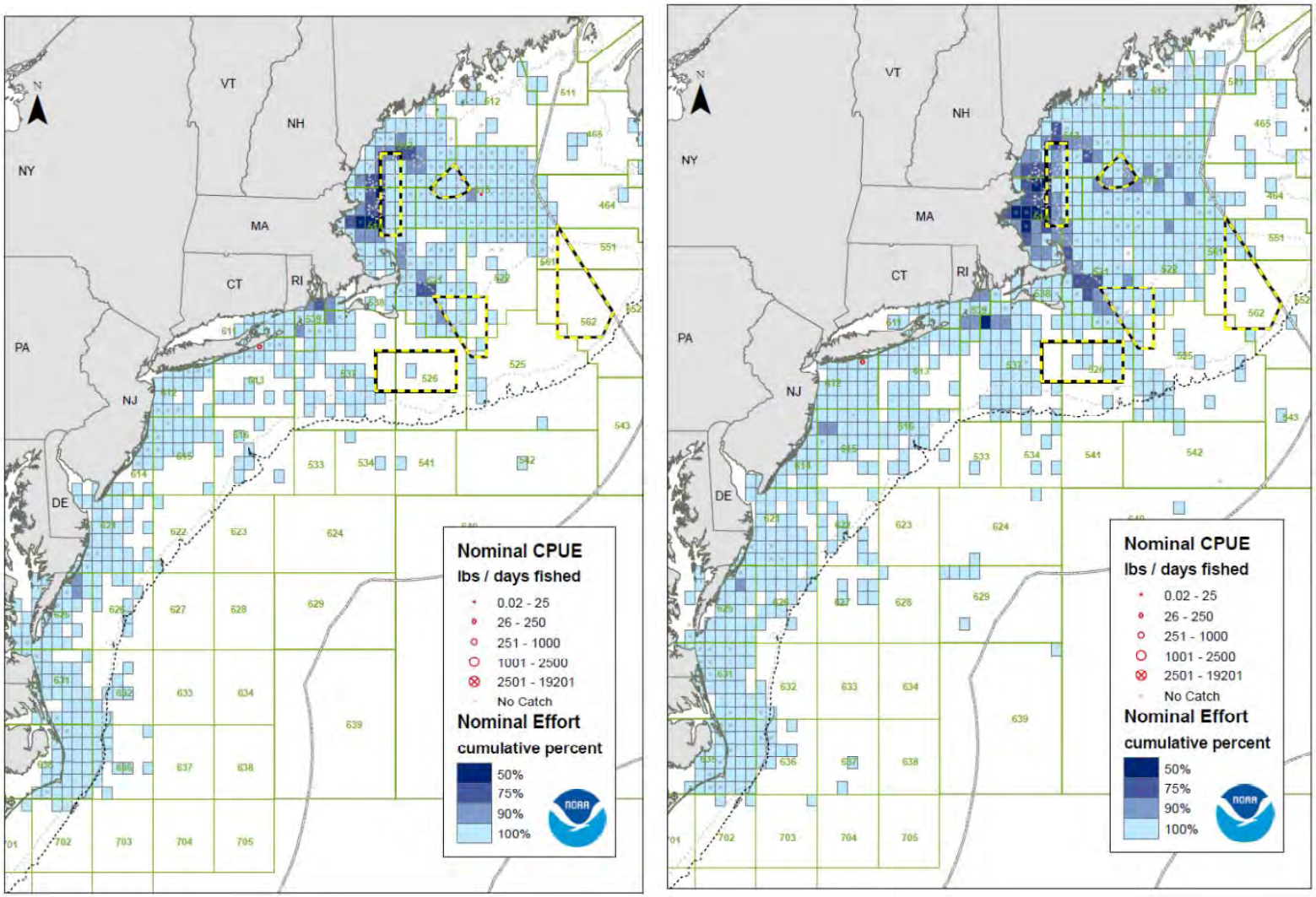
Date: 8/26/2011



American shad - large mesh gillnet - 1999-2004

Date: 8/26/2011

Figure 29. Spatial distribution of nominal effort (days fished from Vessel Trip Reports) for the large mesh (mesh 5.50-7.99 in.) gillnet fleet and the fleet's incidental catch rates (kept+discarded weight/days fished from observed NEFOP trips) of American shad, by ten-minute square, during 2005-2010 and 1999-2004.



Hickory shad - large mesh gillnet - 2005-2010

Date: 8/29/2011

Hickory shad - large mesh gillnet - 1999-2004

Date: 8/29/2011

Figure 30. Spatial distribution of nominal effort (days fished from Vessel Trip Reports) for the large mesh (mesh 5.50-7.99 in.) gillnet fleet and the fleet's incidental catch rates (kept+discarded weight/days fished from observed NEFOP trips) of hickory shad, by ten-minute square, during 2005-2010 and 1999-2004.

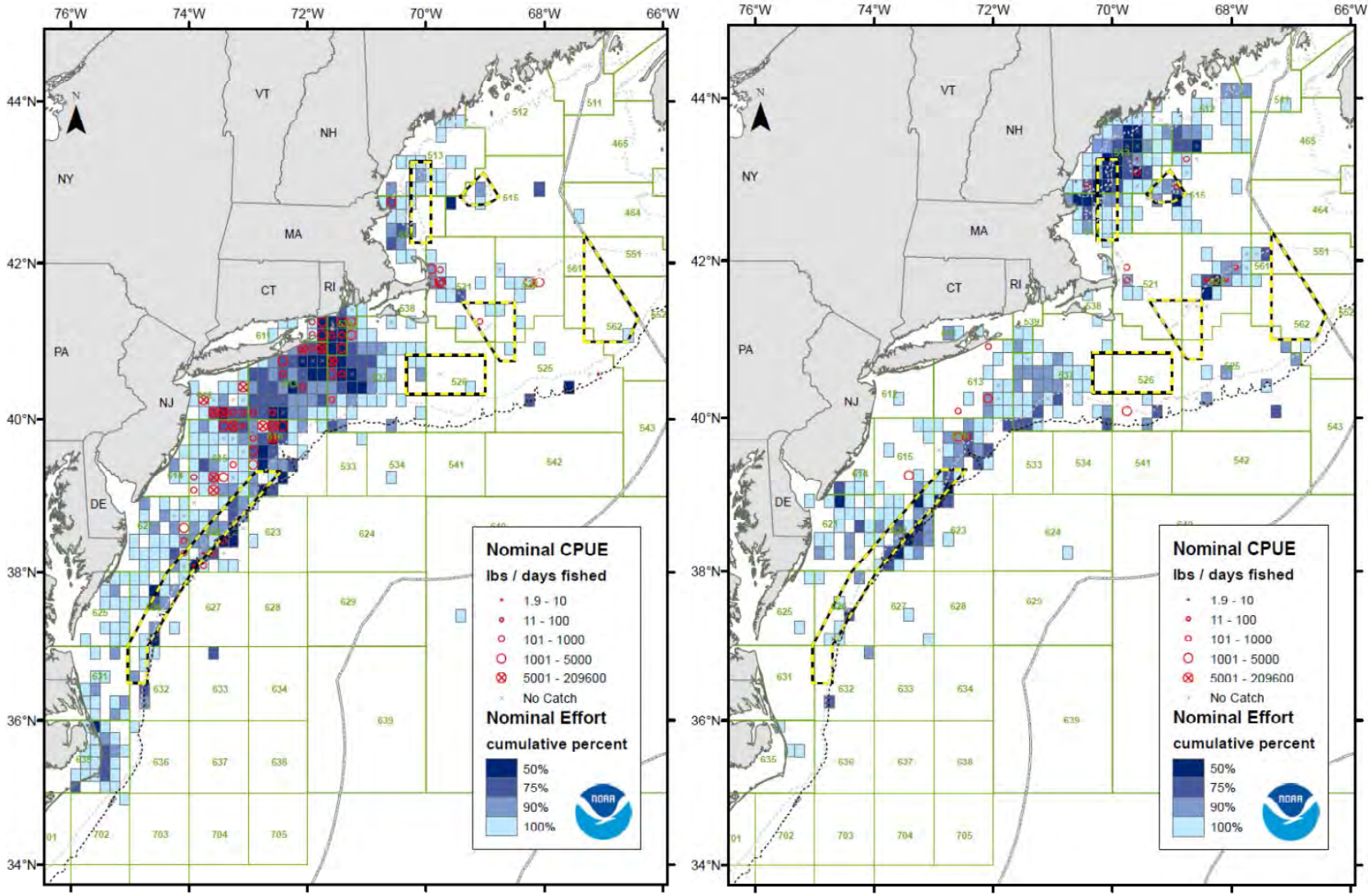


Figure 31. Spatial distribution of nominal effort (days fished from Vessel Trip Reports) for the paired and single midwater trawl fleet and the fleet's incidental catch rates (kept+discarded weight/days fished from observed NEFOP trips) of alewife, blueback herring, hickory shad, and American shad combined, by ten-minute square, during Quarter 1 (left) and 2 (right) for 2005-2010.

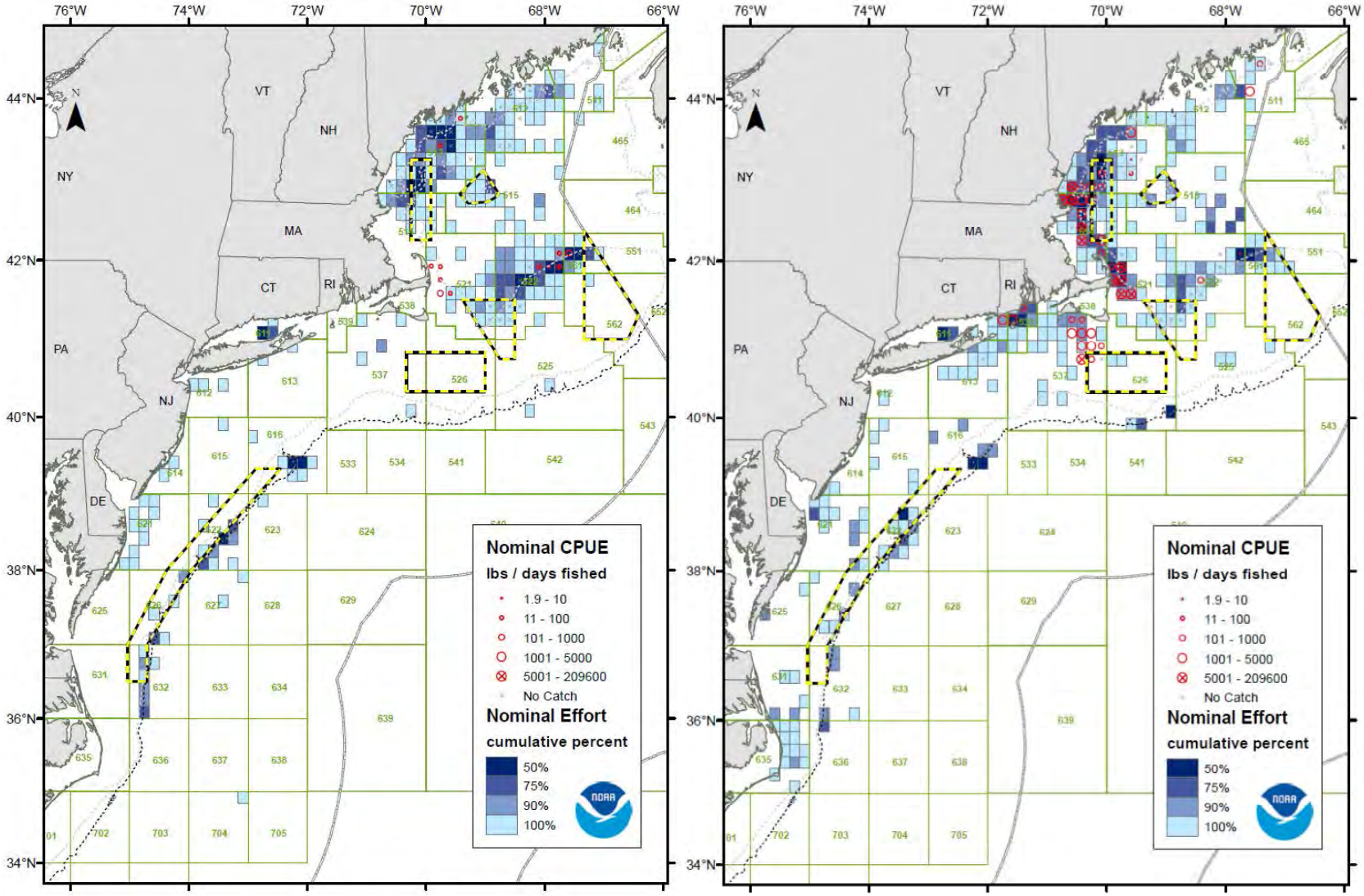


Figure 32. Spatial distribution of nominal effort (days fished from Vessel Trip Reports) for the paired and single midwater trawl fleet and the fleet's incidental catch rates (kept+discarded weight/days fished from observed NEFOP trips) of alewife, blueback herring, hickory shad, and American shad combined, by ten-minute square, during Quarter 3 (left) and 4 (right) for 2005-2010.

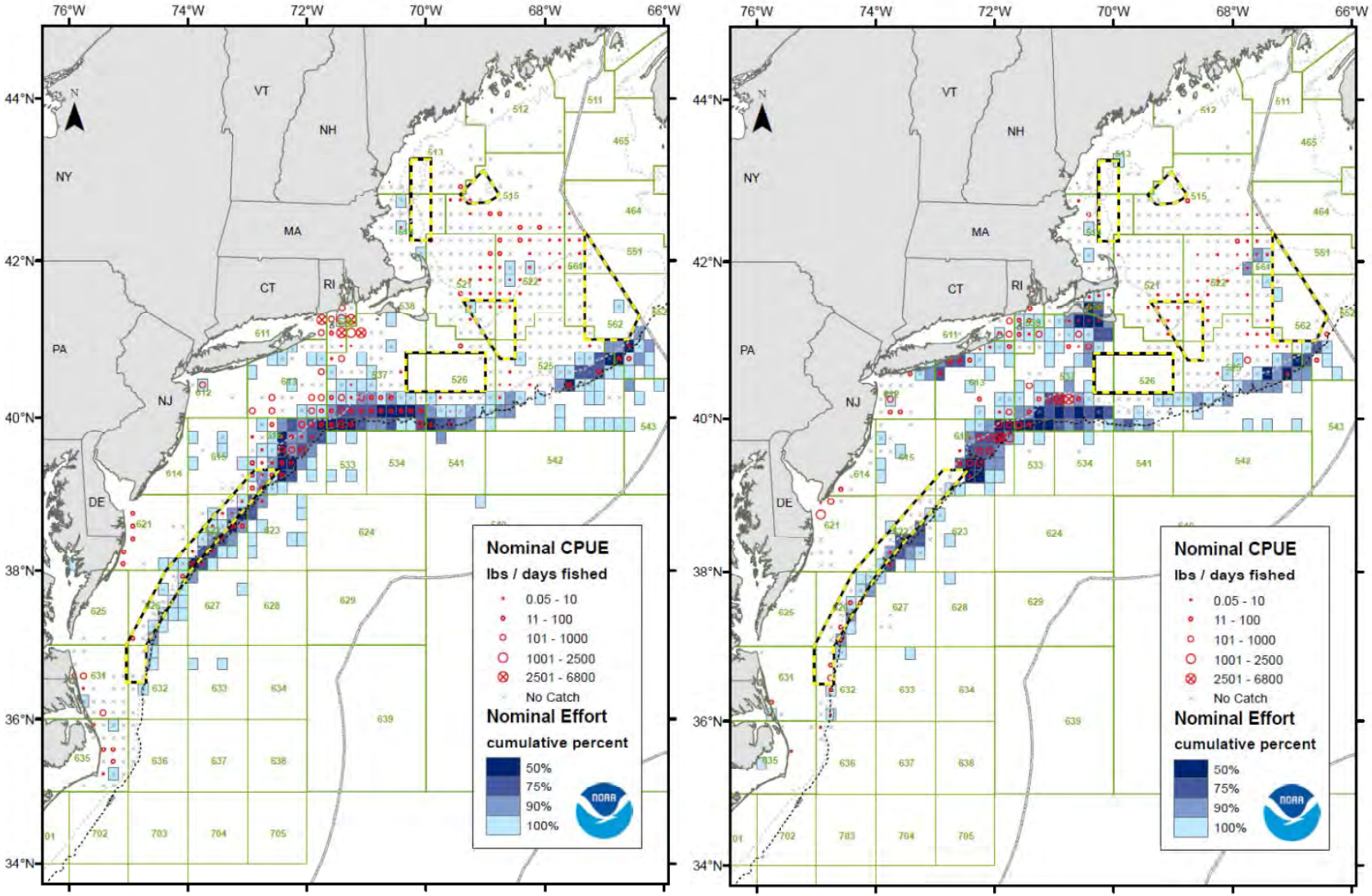


Figure 33. Spatial distribution of nominal effort (days fished from Vessel Trip Reports) for the small mesh (codend mesh ≤ 3.5 in.) bottom trawl fleet and the fleet's incidental catch rates (kept+discarded weight/days fished from observed NEFOP trips) of alewife, blueback herring, hickory shad, and American shad combined, by ten-minute square, during Quarter 1 (left) and 2 (right) for 2005-2010.

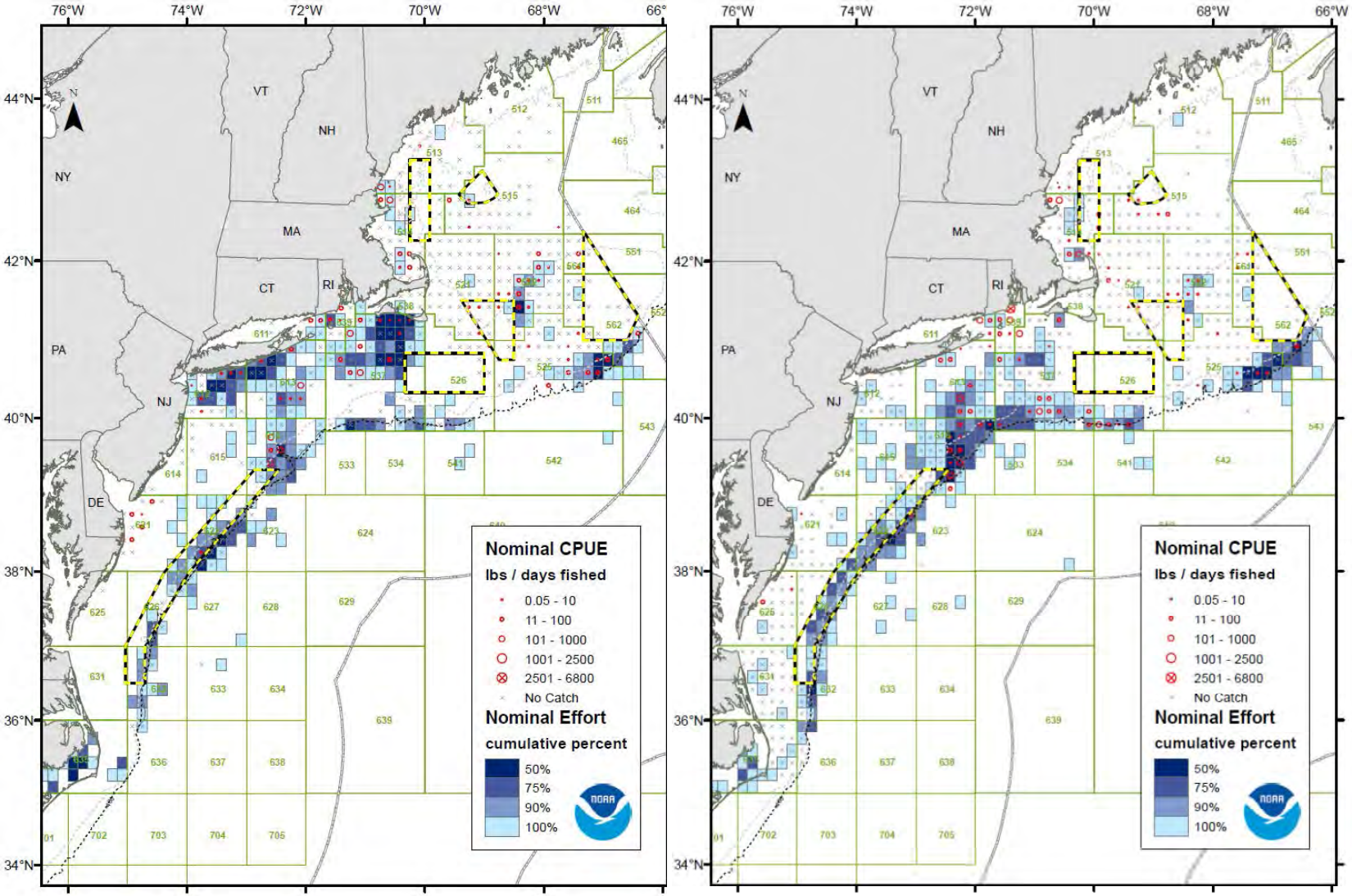


Figure 34. Spatial distribution of nominal effort (days fished from Vessel Trip Reports) for the small mesh (codend mesh ≤ 3.5 in.) bottom trawl fleet and the fleet's incidental catch rates (kept+discarded weight/days fished from observed NEFOP trips) of alewife, blueback herring, hickory shad, and American shad combined, by ten-minute square, during Quarter 3 (left) and 4 (right) for 2005-2010.

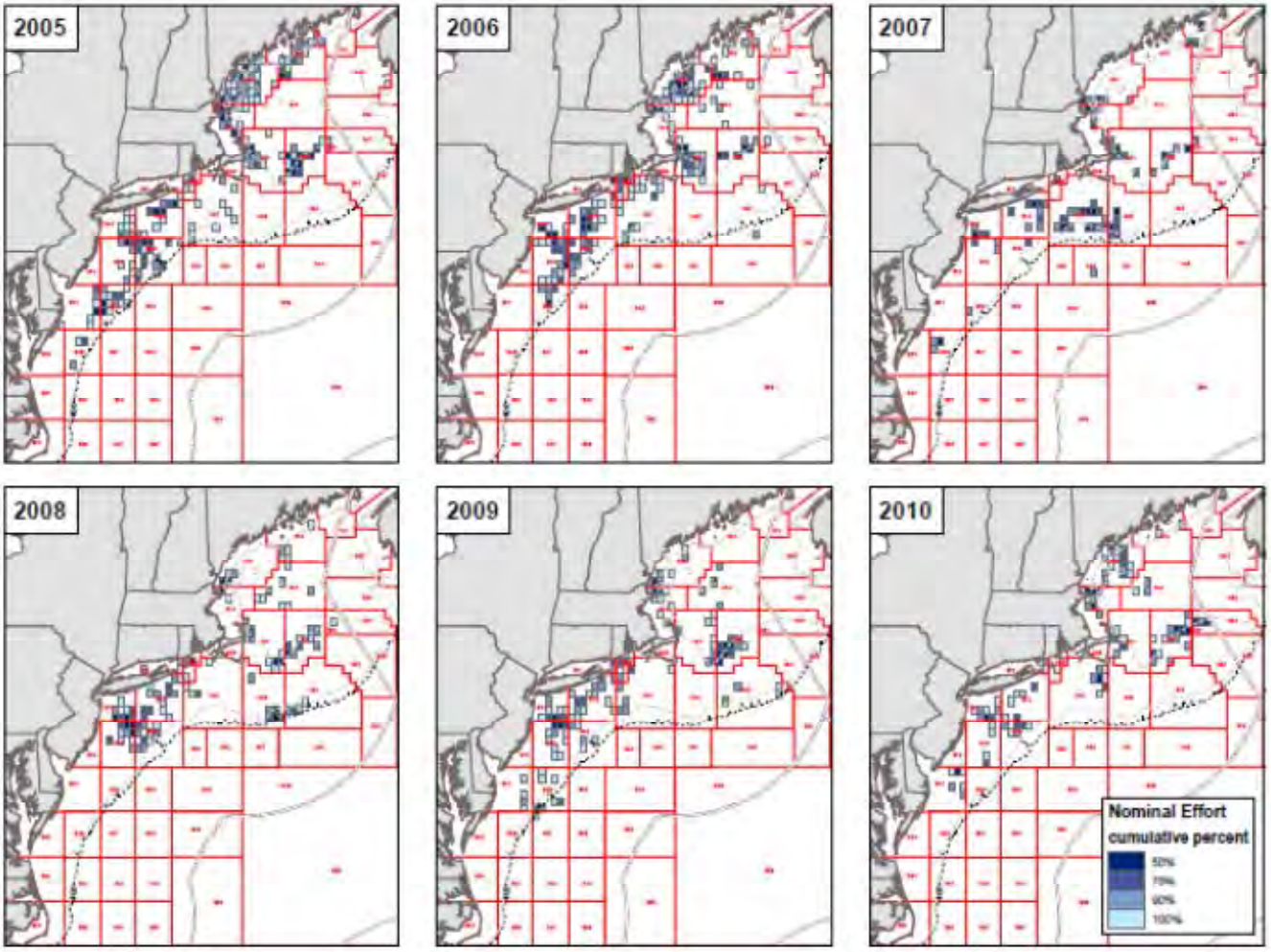


Figure 35. Variability in the spatial distribution of fishing effort (days fished from the Vessel Trip Reports), by the paired midwater trawl fleet, during 2005-2010.

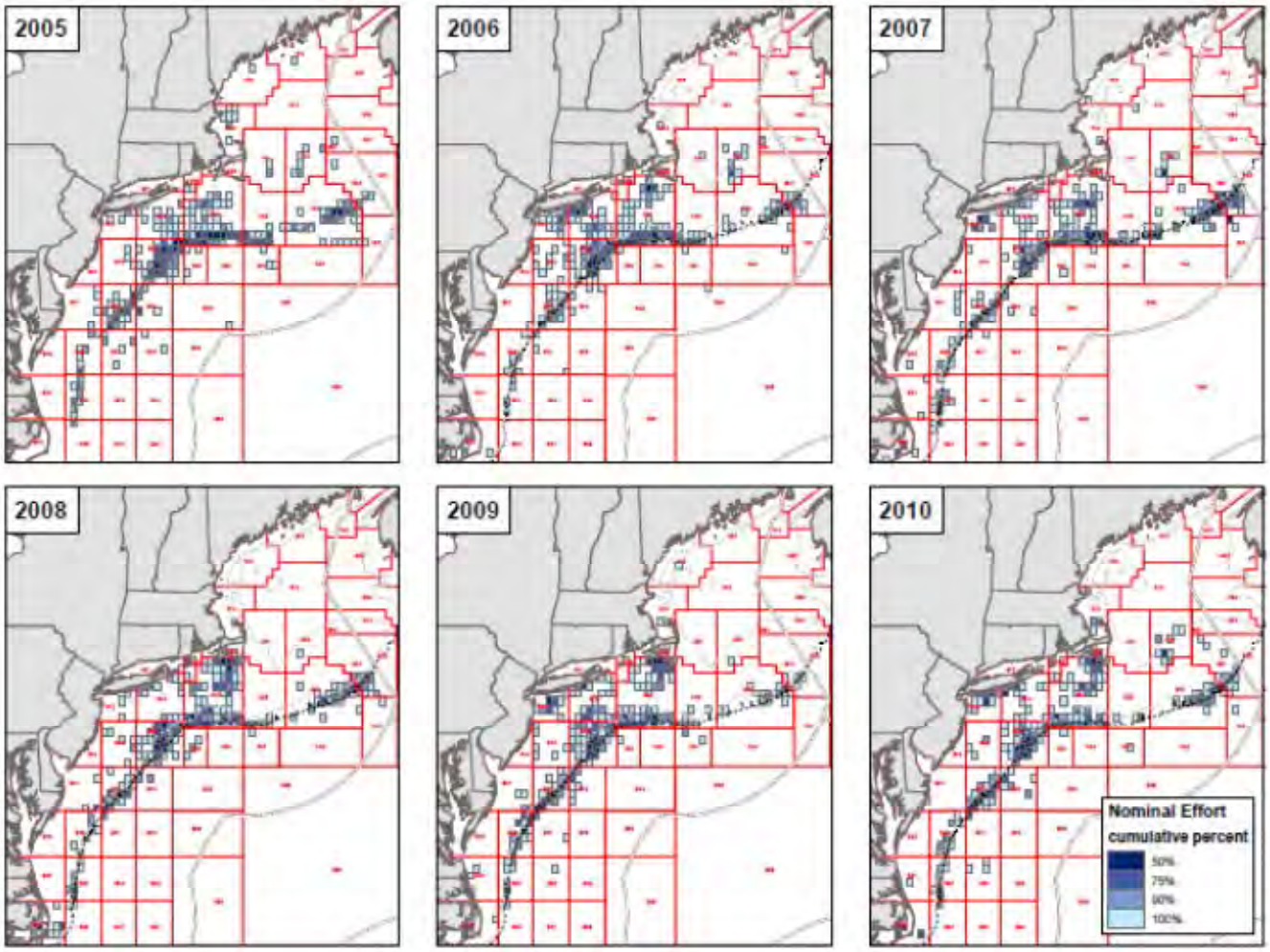


Figure 36. Variability in the spatial distribution of fishing effort (days fished from the Vessel Trip Reports), by the small mesh (codend mesh ≤ 3.5 in.) trawl fleet, during 2005-2010.

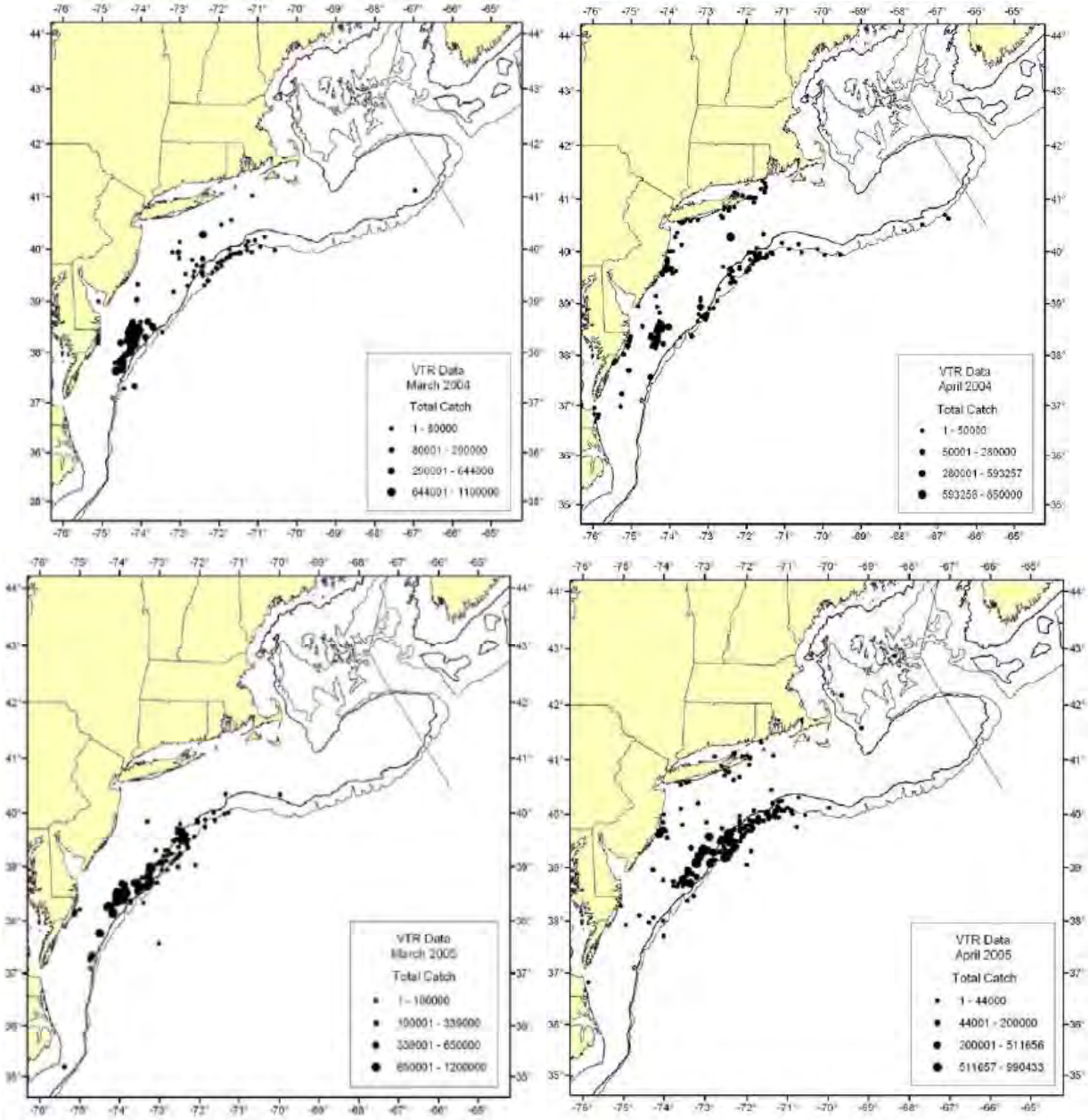


Figure 37. Differences in the spatial distributions of Atlantic mackerel catches during March and April of 2004 (top) versus 2005 (bottom). Each circle may represent a portion of a trip if the trip occurred in different statistical areas. Source: 2009 Working Paper for TRAC assessment of mackerel.

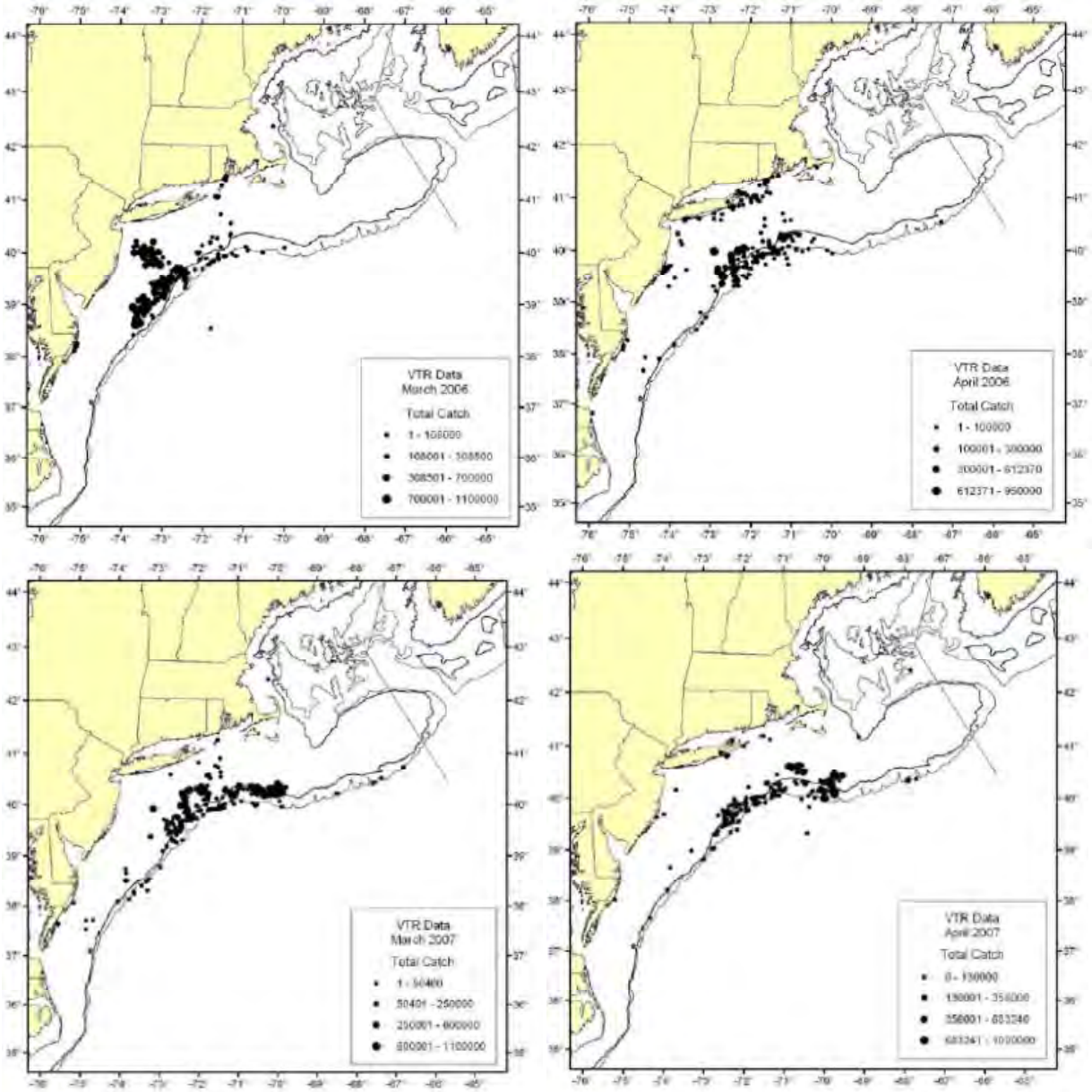


Figure 38. Differences in the spatial distributions of Atlantic mackerel catches during March and April of 2006 (top) versus 2007 (bottom). Each circle may represent a portion of a trip if the trip occurred in different statistical areas. Source: 2009 Working Paper for TRAC assessment of mackerel.

sub Appendix 1 (still part of Appenidx 2)

Table A1: Species-specific total annual incidental catch (mt) and the associated coefficient of variation across all fleets and regions. Midwater trawl estimates were only included beginning in 2005.

	Alewife		American shad		Blueback herring		Herring NK		Hickory Shad	
Year	Catch	CV	Catch	CV	Catch	CV	Catch	CV	Catch	CV
1989	20.35	0.49	58.92	0.60	19.60	0.39	7.08	1.03	0.00	
1990	55.31	0.68	25.81	0.34	78.94	0.44	331.34	0.72	0.00	
1991	68.24	0.48	104.27	0.25	115.41	0.37	110.46	0.48	39.35	0.00
1992	30.56	0.36	79.80	0.29	458.17	0.44	387.54	0.39	0.00	
1993	40.47	0.51	50.96	0.52	210.56	0.40	18.60	0.46	0.00	
1994	5.45	0.30	70.31	0.67	40.16	0.33	9.79	0.59	0.24	0.31
1995	6.36	0.48	17.17	0.41	213.50	0.43	51.89	1.44	0.02	1.42
1996	482.01	1.07	39.99	0.38	1803.43	2.10	28.68	0.43	26.64	0.82
1997	41.25	1.01	37.00	0.67	982.04	0.65	67.60	4.25	18.27	0.90
1998	80.88	1.47	55.31	0.43	49.32	1.27	0.42	0.65	39.19	1.45
1999	3.86	0.96	15.72	0.41	206.66	0.59	128.81	1.26	56.79	0.58
2000	28.37	0.67	74.39	1.82	55.46	0.37	21.96	0.53	0.06	0.80
2001	93.02	1.05	61.92	0.42	120.13	0.47	2.10	0.42	80.62	0.38
2002	2.72	3.86	24.07	0.41	173.23	0.31	76.51	1.85	1.41	1.05
2003	248.43	1.46	21.37	0.91	332.48	0.56	15.31	1.21	14.30	0.89
2004	99.74	0.93	18.16	0.35	81.54	0.47	176.74	0.74	35.03	0.78
2005	347.43	0.42	78.24	0.32	220.04	0.38	7.18	0.60	19.41	0.38
2006	57.61	0.91	29.29	4.37	187.48	0.67	232.02	1.16	13.35	0.81
2007	484.02	0.79	55.08	0.45	180.13	1.47	105.31	2.08	4.77	0.98
2008	145.03	0.43	52.38	0.32	526.59	0.57	327.99	0.40	7.83	0.65
2009	158.66	0.26	59.54	0.45	202.02	0.30	180.05	0.91	10.89	0.83
2010	118.50	0.20	46.12	0.17	125.02	0.20	86.50	0.32	1.12	0.65

Table A2: Mid-Atlantic total annual incidental catch (mt) and the associated coefficient of variation for bottom trawl, single and paired midwater trawls, gillnet, and all other fleets for each individual species. Herring NK represents unknown herring. Midwater trawl estimates are only included beginning in 2005.

		Bottom Trawl		Single MWT		Paired MWT		Gillnet		Other	
Species	**Year**	**Catch**	**CV**	**Catch**	**CV**	**Catch**	**CV**	**Catch**	**CV**	**Catch**	**CV**
Alewife	1989	15.55	0.61					0.00		0.00	
	1990	0.04	1.07					0.00		0.00	
	1991	54.78	0.59					0.00		0.00	
	1992	21.74	0.51					0.00		0.00	
	1993	0.00						0.00		0.00	
	1994	0.00						0.00		0.00	
	1995	0.00	3.28					0.00		0.00	
	1996	386.70	1.33					0.03	0.13	0.00	
	1997	7.63	3.31					0.00		0.00	
	1998	0.00						0.01	0.30	0.00	
	1999	0.13	2.03					0.00		0.76	0.26
	2000	1.38	1.28					0.00		6.70	0.88
	2001	3.24	0.59					0.83	1.49	0.00	
	2002	1.52	6.90					0.00		0.00	
	2003	201.52	1.80					0.00		0.00	
	2004	24.83	1.57					0.00		51.49	1.61
	2005	72.68	0.70	21.35	1.43	162.03	0.78	0.14	1.08	0.00	
	2006	19.97	2.47	13.96	1.07	2.61	1.11	0.00		0.00	
	2007	8.87	3.12	0.00		0.00		0.00		0.00	
	2008	5.20	1.71	1.81	0.57	4.51	0.69	0.00		0.00	
	2009	4.24	1.10	24.06	0.98	27.90	0.63	0.00		0.00	
	2010	6.85	0.51	3.16	0.92	5.40	0.52	0.00		0.01	0.97
American Shad	1989	13.32	0.41					0.00		0.00	
	1990	4.15	0.46					0.00		0.00	
	1991	28.95	0.50					0.00		0.00	
	1992	20.25	0.42					0.00		0.00	
	1993	0.71	1.29					0.00		0.00	
	1994	45.73	1.00					0.43	0.11	0.00	
	1995	0.46	3.63					1.14	0.55	0.00	
	1996	2.44	0.51					8.66	0.57	0.00	
	1997	11.21	1.92					2.78	0.20	0.00	
	1998	9.49	1.05					20.64	0.34	0.00	
	1999	1.77	1.89					5.40	0.49	1.48	1.33
	2000	0.11	0.52					4.27	0.87	64.25	2.11
	2001	0.78	0.77					59.09	0.44	0.00	

Species	Year	Bottom Trawl Catch	Bottom Trawl CV	Single MWT Catch	Single MWT CV	Paired MWT Catch	Paired MWT CV	Gillnet Catch	Gillnet CV	Other Catch	Other CV
	2002	0.40	0.73					1.93	0.41	0.00	
	2003	9.41	2.03					1.25	0.59	0.01	1.06
	2004	3.85	0.62					0.13	0.39	0.04	0.86
	2005	8.83	0.40	0.48	1.43	27.30	0.53	0.00		0.00	
	2006	0.63	2.03	3.92	1.07	0.00		11.89	10.70	0.00	
	2007	7.75	1.93	0.00		0.00		0.83	2.49	0.00	
	2008	0.85	0.79	1.40	0.27	13.84	0.94	0.00		0.00	
	2009	2.78	0.60	0.12	1.07	0.05	1.02	2.97	6.78	0.00	
	2010	13.97	0.43	0.00		0.93	0.76	0.00		0.00	
Blueback Herring	1989	8.93	0.65					0.00		0.00	
	1990	56.86	0.48					0.00		0.00	
	1991	49.54	0.53					0.00		0.00	
	1992	360.88	0.44					0.00		0.00	
	1993	112.69	0.53					0.00		0.12	1.15
	1994	0.00						0.00		0.00	
	1995	2.24	3.33					0.17	1.55	0.00	
	1996	1777.32	2.13					0.03	0.87	0.00	
	1997	878.61	0.67					0.09	0.48	0.00	
	1998	49.05	1.28					0.11	0.23	0.00	
	1999	0.10	0.52					0.01	1.34	0.00	
	2000	54.02	0.38					0.00		0.00	
	2001	78.34	0.49					0.19	0.78	0.02	2.11
	2002	11.52	0.76					0.00		0.00	
	2003	37.41	1.91					0.15	0.47	0.00	
	2004	22.23	1.11					0.03	1.04	0.00	
	2005	16.76	0.45	1.31	0.91	123.94	0.61	0.00		0.00	
	2006	2.99	3.65	151.37	0.81	19.07	1.13	0.01	0.88	0.00	
	2007	1.21	1.33	0.00		0.00		0.00		0.02	0.94
	2008	0.30	1.09	1.58	0.35	380.77	0.75	0.00		0.00	
	2009	5.57	0.32	27.99	0.96	51.90	0.74	0.00		0.01	0.88
	2010	7.81	0.86	1.66	0.65	7.51	0.88	0.00		0.01	1.03
Herring NK	1989	0.00						0.00		0.00	
	1990	111.73	0.69					0.00		0.00	
	1991	76.60	0.56					0.00		0.00	
	1992	53.54	0.65					0.00		0.00	
	1993	3.65	0.00					0.00		0.00	
	1994	0.08	1.00					0.38	0.10	0.00	
	1995	0.36	2.82					0.03	0.49	0.07	1.13
	1996	7.01	0.79					0.32	0.84	0.00	

Species	Year	Bottom Trawl Catch	Bottom Trawl CV	Single MWT Catch	Single MWT CV	Paired MWT Catch	Paired MWT CV	Gillnet Catch	Gillnet CV	Other Catch	Other CV
	1997	0.00						0.00		0.00	
	1998	0.07	1.85					0.16	0.25	0.00	
	1999	45.35	2.06					0.14	1.09	0.00	
	2000	0.64	0.98					0.23	0.63	6.34	0.94
	2001	0.93	0.80					0.12	0.62	0.00	
	2002	2.21	0.73					0.00		0.00	
	2003	0.00						0.02	1.68	0.01	1.29
	2004	167.25	0.78					0.00		0.00	
	2005	1.89	0.73	0.00		0.00		0.06	1.50	0.07	0.19
	2006	0.00		0.00		0.00		0.09	0.96	0.00	
	2007	10.41	4.76	0.00		0.10	0.73	22.37	0.86	0.00	
	2008	52.40	1.12	75.02	0.53	0.00		0.00		0.00	
	2009	3.84	0.71	0.00		158.78	1.02	0.00		0.79	0.82
	2010	43.02	0.58	0.00		0.03	0.97	0.00		2.96	0.95
Hickory Shad	1989	0.00						0.00		0.00	
	1990	0.00						0.00		0.00	
	1991	0.00						0.00		39.35	0.00
	1992	0.00						0.00		0.00	
	1993	0.00						0.00		0.00	
	1994	0.00						0.11	0.17	0.00	
	1995	0.02	2.09					0.01	0.11	0.00	
	1996	8.92	0.57					0.47	0.32	0.00	
	1997	4.82	2.18					5.41	0.80	0.00	
	1998	0.00						0.47	0.39	0.31	0.98
	1999	0.11	2.47					0.14	0.71	52.14	0.63
	2000	0.00						0.05	0.87	0.00	
	2001	3.10	1.04					10.99	0.53	0.00	
	2002	0.00						1.28	1.15	0.00	
	2003	4.58	2.61					1.52	1.73	5.35	0.40
	2004	5.44	1.60					19.91	1.25	1.60	2.28
	2005	7.32	0.41	0.08	0.69	0.06	0.89	0.12	1.27	0.00	
	2006	3.83	0.75	0.00		0.00		0.00		0.00	
	2007	1.59	2.86	0.00		0.00		0.44	0.77	0.00	
	2008	0.26	0.88	0.00		0.00		0.00		3.63	1.20
	2009	0.18	1.14	0.00		0.00		1.35	2.36	7.14	1.17
	2010	0.02	0.51	0.00		0.00		0.32	0.70	0.64	1.08

Table A3: New England total annual incidental catch (mt) and the associated coefficient of variation for bottom trawl, single and paired midwater trawls, gillnet, and all other fleets for each individual species. Herring NK represents unknown herring. Midwater trawl estimates are only included beginning in 2005.

		Bottom Trawl		Single MWT		Paired MWT		Gillnet		Other	
Species	**Year**	**Catch**	**CV**	**Catch**	**CV**	**Catch**	**CV**	**Catch**	**CV**	**Catch**	**CV**
Alewife	1989	4.66	0.63					0.00		0.13	0.95
	1990	55.27	0.68					0.00		0.00	
	1991	4.02	0.62					0.00		9.44	0.44
	1992	1.92	0.45					0.00		6.90	0.25
	1993	33.80	0.61					0.00		6.67	0.28
	1994	0.08	1.56					0.00		5.36	0.31
	1995	2.10	1.37					0.09	1.07	4.17	0.25
	1996	38.37	0.39					1.31	1.02	55.60	0.47
	1997	10.08	3.16					0.00		23.54	0.40
	1998	80.88	1.47					0.00		0.00	
	1999	2.96	1.24					0.00		0.00	
	2000	20.30	0.88					0.00		0.00	
	2001	88.94	1.10					0.00		0.00	
	2002	1.20	0.78					0.00		0.00	
	2003	38.87	0.57					0.03	0.66	8.02	0.46
	2004	21.31	0.59					0.04	0.55	2.08	0.74
	2005	12.98	0.75	1.92	0.90	71.99	0.48	0.02	0.56	4.32	0.52
	2006	15.86	0.52	1.34	1.56	1.81	0.72	0.00		2.05	0.43
	2007	259.38	0.41	116.52	2.89	97.42	1.42	0.02	1.41	1.82	0.80
	2008	31.84	0.85	40.49	1.04	60.46	0.60	0.00		0.71	0.38
	2009	31.26	0.51	10.60	0.53	57.29	0.42	0.01	0.63	3.30	0.41
	2010	28.62	0.40	0.58	0.36	69.08	0.28	0.02	0.49	4.79	0.34
American Shad	1989	45.43	0.77					0.00		0.18	1.02
	1990	18.86	0.44					0.00		2.79	0.56
	1991	70.77	0.30					0.00		4.54	1.11
	1992	56.54	0.38					0.00		3.01	0.41
	1993	49.68	0.53					0.00		0.57	0.97
	1994	22.86	0.55					1.12	0.88	0.16	0.76
	1995	6.52	0.96					8.89	0.29	0.16	1.05
	1996	1.05	4.45					27.82	0.48	0.03	1.10
	1997	13.68	0.87					5.01	0.44	4.31	0.60
	1998	16.98	1.20					8.19	0.44	0.00	
	1999	0.93	0.64					6.15	0.71	0.00	
	2000	1.50	1.20					4.25	0.51	0.00	
	2001	1.98	0.62					0.07	1.66	0.00	

Species	Year	Bottom Trawl Catch	Bottom Trawl CV	Single MWT Catch	Single MWT CV	Paired MWT Catch	Paired MWT CV	Gillnet Catch	Gillnet CV	Other Catch	Other CV
	2002	4.56	1.41					17.17	0.44	0.00	
	2003	8.52	0.41					2.18	0.78	0.02	1.07
	2004	11.52	0.52					2.63	0.26	0.00	1.29
	2005	7.59	0.48	1.98	1.04	29.97	0.67	2.09	0.25	0.00	
	2006	3.04	0.60	0.00		0.18	0.63	9.46	1.18	0.15	1.06
	2007	1.45	0.28	0.00		17.15	0.78	27.86	0.52	0.03	0.95
	2008	2.95	0.38	2.57	1.09	2.43	0.84	28.30	0.37	0.04	0.99
	2009	17.98	0.51	20.64	0.69	6.76	0.34	7.83	0.28	0.42	0.83
	2010	11.22	0.25	0.11	0.49	10.28	0.37	9.61	0.19	0.00	
Blueback Herring	1989	8.20	0.56					0.00		2.48	0.69
	1990	19.64	1.11					0.00		2.44	0.60
	1991	57.25	0.58					0.00		8.62	0.83
	1992	85.85	1.45					0.00		11.44	0.50
	1993	96.72	0.61					0.00		1.02	0.55
	1994	32.99	0.37					6.64	0.84	0.53	0.71
	1995	59.07	0.83					104.57	0.71	47.44	0.48
	1996	1.53	1.35					0.23	0.73	24.33	0.36
	1997	51.56	4.66					0.00		51.79	0.51
	1998	0.00						0.17	0.72	0.00	
	1999	206.56	0.59					0.00		0.00	
	2000	1.43	0.87					0.00		0.01	0.67
	2001	41.50	1.00					0.00		0.08	0.96
	2002	161.07	0.33					0.64	1.23	0.00	
	2003	279.00	0.61					0.02	0.79	15.90	0.41
	2004	54.11	0.55					1.83	0.69	3.34	0.61
	2005	15.75	0.70	14.03	1.22	45.50	0.55	0.23	0.80	2.53	0.75
	2006	3.14	0.82	7.06	0.73	3.65	0.77	0.00		0.17	0.76
	2007	38.65	0.60	72.91	3.51	64.97	1.05	0.01	1.32	2.37	0.83
	2008	13.73	0.83	17.46	0.76	109.73	0.84	0.02	1.31	3.01	0.77
	2009	42.84	0.56	9.85	0.56	61.42	0.46	0.03	0.84	2.40	0.47
	2010	9.79	0.41	0.39	1.09	74.45	0.27	0.07	0.39	23.34	0.45
Herring NK	1989	7.08	1.03					0.00		0.00	
	1990	218.18	1.04					0.00		1.43	0.82
	1991	28.44	1.04					0.00		5.43	1.35
	1992	318.11	0.46					0.00		15.88	0.37
	1993	14.75	0.58					0.00		0.20	0.51
	1994	2.26	0.53					6.73	0.84	0.35	0.56
	1995	44.96	1.66					3.69	0.59	2.79	0.91
	1996	20.80	0.53					0.30	0.99	0.25	1.08

		Bottom Trawl		Single MWT		Paired MWT		Gillnet		Other	
Species	**Year**	**Catch**	**CV**	**Catch**	**CV**	**Catch**	**CV**	**Catch**	**CV**	**Catch**	**CV**
	1997	67.48	4.26					0.08	1.28	0.04	0.64
	1998	0.18	1.27					0.00		0.00	
	1999	83.28	1.59					0.03	1.15	0.00	
	2000	14.75	0.68					0.00		0.01	1.03
	2001	0.00						0.05	1.54	1.00	0.46
	2002	74.30	1.91					0.00		0.00	
	2003	15.25	1.21					0.03	0.59	0.00	
	2004	9.47	0.63					0.02	0.57	0.00	
	2005	3.20	1.24	0.15	1.36	0.00		0.17	0.52	1.64	0.55
	2006	57.53	1.49	168.41	1.52	0.00		2.25	0.50	3.75	0.58
	2007	72.42	2.93	0.00		0.00		0.00		0.00	
	2008	97.17	0.58	0.98	1.13	0.00		0.00		102.41	0.93
	2009	15.01	1.48	0.00		0.67	0.91	0.63	0.62	0.35	0.78
	2010	8.52	0.90	0.49	0.46	17.84	0.18	0.29	0.46	13.34	0.55
	1989	0.00						0.00		0.00	
	1990	0.00						0.00		0.00	
	1991	0.00						0.00		0.00	
	1992	0.00						0.00		0.00	
	1993	0.00						0.00		0.00	
	1994	0.10	0.63					0.00		0.03	1.05
	1995	0.00						0.00		0.00	
	1996	17.26	1.24					0.00		0.00	
	1997	3.68	3.16					0.00		4.37	0.63
	1998	38.40	1.48					0.00		0.00	
Hickory Shad	1999	4.40	0.70					0.00		0.00	
	2000	0.00	0.83					0.00		0.00	
	2001	66.53	0.45					0.00		0.00	
	2002	0.12	1.00					0.00		0.00	
	2003	2.59	1.02					0.27	0.46	0.00	
	2004	8.04	0.78					0.04	0.84	0.00	
	2005	2.68	0.45	2.58	1.37	6.56	0.86	0.01	0.85	0.00	
	2006	9.32	1.12	0.15	1.56	0.00		0.04	1.00	0.01	1.06
	2007	1.99	0.38	0.37	1.66	0.00		0.28	1.33	0.11	0.98
	2008	0.90	0.52	0.00		2.89	0.88	0.02	0.91	0.12	1.01
	2009	2.05	0.76	0.00		0.00		0.17	0.61	0.00	
	2010	0.06	0.67	0.00	0.19	0.00		0.08	0.68	0.00	

Table A4: Mid-Atlantic 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	15.55	0.61	0.00		0.00		0.00		0.00			
	1990	0.04	1.07	0.00		0.00		0.00		0.00		0.00	
	1991	54.78	0.59	0.00		0.00		0.00		0.00			
	1992	21.72	0.51	0.00		0.02	1.10	0.00		0.00			
	1993	0.00		0.00		0.00		0.00		0.00			
	1994	0.00		0.00		0.00		0.00		0.00		0.00	
	1995	0.00	3.28	0.00		0.00		0.00		0.00		0.00	
	1996	386.66	1.33	0.04	0.53	0.00		0.03	0.12	0.00	0.81	0.00	
	1997	6.74	3.75	0.89	0.44	0.00		0.00		0.00		0.00	
	1998	0.00		0.00		0.00		0.01	0.30	0.00		0.00	
	1999	0.13	2.03	0.00		0.00		0.00		0.00		0.00	
	2000	1.38	1.28	0.00		0.00		0.00		0.00		0.00	
	2001	3.24	0.59	0.00		0.00		0.83	1.49	0.00		0.00	
	2002	1.52	6.90	0.00		0.00		0.00		0.00		0.00	
	2003	201.52	1.80	0.00		0.00		0.00		0.00		0.00	
	2004	24.29	1.61	0.54	0.50	0.00		0.00		0.00		0.00	
	2005	71.58	0.71	1.11	3.34	0.00		0.14	1.08	0.00		0.00	
	2006	19.20	2.57	0.10	2.74	0.67	1.95	0.00		0.00		0.00	
	2007	8.86	3.12	0.01	0.58	0.00		0.00		0.00		0.00	
	2008	4.95	1.80	0.02	1.38	0.24	0.74	0.00		0.00		0.00	
	2009	3.62	1.28	0.09	1.04	0.53	0.82	0.00		0.00		0.00	
	2010	6.63	0.53	0.06	0.45	0.16	0.95	0.00		0.00		0.00	
American Shad	1989	11.34	0.48	0.00		1.98	0.00	0.00		0.00			
	1990	4.15	0.46	0.00		0.00		0.00		0.00		0.00	
	1991	16.27	0.49	12.67	0.94	0.00		0.00		0.00			
	1992	20.13	0.42	0.00		0.12	0.51	0.00		0.00			
	1993	0.71	1.29	0.00		0.00		0.00		0.00			
	1994	45.69	1.00	0.00		0.04	0.75	0.42	0.11	0.01	0.27	0.00	
	1995	0.43	3.92	0.03	0.90	0.00		0.36	1.56	0.78	0.35	0.00	
	1996	2.42	0.51	0.02	7.54	0.00		7.27	0.68	1.39	0.28	0.00	
	1997	6.17	3.48	5.04	0.40	0.00		0.53	0.54	2.23	0.22	0.02	0.86
	1998	9.49	1.05	0.00		0.00		13.36	0.51	6.49	0.23	0.79	0.87
	1999	1.57	2.12	0.19	0.91	0.00		1.75	0.77	3.64	0.62	0.00	
	2000	0.11	0.52	0.00		0.00		0.00	1.08	4.27	0.87	0.00	
	2001	0.61	0.68	0.18	2.48	0.00		58.84	0.44	0.25	0.65	0.00	

		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
	2002	0.40	0.73	0.00		0.00		1.65	0.48	0.29	0.19	0.00	
	2003	9.41	2.03	0.00		0.00		0.12	0.70	1.12	0.65	0.00	
	2004	3.23	0.73	0.25	0.83	0.38	0.70	0.13	0.39	0.00		0.00	
	2005	7.88	0.44	0.01	3.34	0.94	0.59	0.00		0.00		0.00	
	2006	0.63	2.03	0.00		0.00		0.11	0.34	11.79	10.80	0.00	
	2007	4.68	3.16	3.07	0.76	0.00		0.44	1.06	0.39	5.17	0.00	
	2008	0.51	1.27	0.35	0.60	0.00		0.00		0.00		0.00	
	2009	2.39	0.69	0.26	0.69	0.13	0.85	0.69	2.17	2.28	8.80	0.00	
	2010	13.51	0.45	0.38	0.51	0.08	1.11	0.00		0.00		0.00	
	1989	8.93	0.65	0.00		0.00		0.00		0.00			
	1990	49.94	0.52	6.93	1.22	0.00		0.00		0.00		0.00	
	1991	49.53	0.53	0.01	1.06	0.00		0.00		0.00			
	1992	360.88	0.44	0.00		0.00		0.00		0.00			
	1993	112.69	0.53	0.00		0.00		0.00		0.00			
	1994	0.00		0.00		0.00		0.00		0.00		0.00	
	1995	2.18	3.43	0.00		0.06	1.21	0.10	2.56	0.07	0.40	0.00	
	1996	1777.32	2.13	0.00		0.00		0.03	0.93	0.00	0.86	0.00	
	1997	877.27	0.68	1.34	1.30	0.00		0.00		0.02	0.52	0.07	0.60
	1998	49.05	1.28	0.00		0.00		0.04	0.30	0.07	0.33	0.00	0.91
Blueback Herring	1999	0.10	0.52	0.00		0.00		0.01	1.34	0.00		0.00	
	2000	54.02	0.38	0.00		0.00		0.00		0.00		0.00	
	2001	78.34	0.49	0.00		0.00		0.00		0.00		0.19	0.78
	2002	11.52	0.76	0.00		0.00		0.00		0.00		0.00	
	2003	37.41	1.91	0.00		0.00		0.15	0.47	0.00		0.00	
	2004	18.21	1.35	3.90	0.56	0.13	1.06	0.00		0.00		0.03	1.04
	2005	16.61	0.45	0.13	0.52	0.02	0.91	0.00		0.00		0.00	
	2006	2.79	3.91	0.20	0.60	0.00		0.01	0.88	0.00		0.00	
	2007	0.72	2.20	0.49	0.58	0.00		0.00		0.00		0.00	
	2008	0.30	1.09	0.00		0.00		0.00		0.00		0.00	
	2009	5.40	0.32	0.00		0.17	0.75	0.00		0.00		0.00	
	2010	7.74	0.87	0.01	0.47	0.06	1.09	0.00		0.00		0.00	
	1989	0.00		0.00		0.00		0.00		0.00			
	1990	111.73	0.69	0.00		0.00		0.00		0.00		0.00	
	1991	76.60	0.56	0.00		0.00		0.00		0.00			
Herring NK	1992	51.48	0.67	2.07	1.56	0.00		0.00		0.00			
	1993	0.00		3.65	0.00	0.00		0.00		0.00			
	1994	0.08	1.00	0.00		0.00		0.38	0.10	0.00	0.63	0.00	
	1995	0.31	3.25	0.00		0.05	1.09	0.00	0.18	0.03	0.51	0.00	
	1996	7.01	0.79	0.00		0.00		0.29	0.93	0.03	0.81	0.00	

		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	
	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	
Hickory Shad	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	

		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
	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

		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	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
Hickory Shad	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	
	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	