Northwest Atlantic Fisheries Organization

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United States Research Report for 2012

by

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A. Status of the Fisheries (Subareas 3- 6 Inclusive)

Brief summaries are provided on the status of fisheries for major species of finfish and shellfish. Detailed information on these species and other species found off the northeastern coast of the United States can be found at http://www.nefsc.noaa.gov/sos/.

Revised sampling and protocols were implemented in the Northeast Region in 1994 and then again revised in 2004. Auditing and allocation procedures have been used to prorate total reported landings by species among areas. However, these procedures are subject to change and the landings, by area, are therefore still considered provisional.

Some spring and autumn survey indices for 2009-2012 were converted from the FSV *Henry B. Bigelow* catches (weights) to RV *Albatross IV* catches (weights) using a single conversion factor for each species. Length-specific conversion factors may be more appropriate, but these have only been estimated for some species. Consequently, 2009-2012 survey data points should be interpreted cautiously, and these values may change in the future as new methodologies are considered. The 2009-2012 data points have been plotted separately in the figures presenting spring and fall survey data.

For the last few years, the United States has been allocated yellowtail flounder quota in Division 3N and in 2012, a vessel fished in the area. The sections for cod, yellowtail flounder, halibut, other flounders, and skates contain the landings and the discards of these species.

1. Atlantic Cod

USA commercial landings of Atlantic cod (*Gadus morhua*) from Subareas 5&6 in 2012 were 4,768 mt, a 40% decrease from the 2011 landings of 7,985 mt and a 41% decrease from the 2010 landings of 8,044 mt. In addition, 5 mt of cod were discarded in NAFO Div. 3N.

USA cod landings from the Gulf of Maine (Div. 5Y) in 2012 were 2,760 mt compared to 4,598 mt in 2011. Northeast Fisheries Science Center (NEFSC) research vessel survey biomass indices in the Gulf of Maine increased from 1993 through 2001. The sharp increase in the autumn 2002 index cannot be explained by the dynamics of the stock, and was largely driven by an extremely large catch at one station. Since 2000, the autumn survey biomass index has remained slightly above the low values of the 1990s (Figure 1). The 2012 spring biomass index is the lowest in the time series and the fall survey index is the second lowest in the time series.

USA cod landings from Georges Bank (Div. 5Z and SA 6) in 2012 were 2,008 mt compared to 3,387 mt in 2011. The NEFSC research vessel survey biomass indices for the Georges Bank stock have remained low since 1991, with the exception of the higher 2002 index, due primarily to a larger catch at one station and

the higher 2004 index, due to recruitment of the 2003 year class. The 2012 autumn survey biomass index was below the long term average (Figure 2).

2. Haddock

United States commercial landings of haddock (*Melanogrammus aeglefinus*) decreased 65% from 5,696 mt in 2011 to 1,970 mt in 2012. Landings for Georges Bank (Div. 5Z) haddock decreased from 5,210 mt in 2011 to 1,549 mt in 2012. Gulf of Maine (Div. 5Y) haddock landings decreased from 485 mt in 2011 to 421 mt in 2012.

The autumn research vessel survey biomass indices for the Gulf of Maine stock declined from 4.1 kg/tow in 2011 to 2.9 kg/tow in 2012 (Figure 3). Gulf of Maine stock biomass has decreased from a recent high in 2000 as the strong 1998 year class has experienced both natural and fishing mortality. The autumn survey biomass for Georges Bank haddock recently peaked at 55.8 kg/tow in 2004. Since 2004, large fluctuations have occurred in the survey index. Mean biomass per tow was fairly constant during 2011 and 2012 at 35.7 kg/tow and 35.1 kg/tow, respectively (Figure 4).

3. Redfish

USA landings of Acadian redfish (*Sebastes fasciatus*) increased by 91% from 2,014 mt in 2011 to 3,838 mt in 2012, the annual catch since 1985. Fall research vessel survey biomass indices have increased since 1996 (Figure 5) and the 2010 and 2012 indices are the highest on record. Recent trajectories of biomass indices and landings reflect continued stock rebuilding.

4. Pollock (USA Waters of Areas 5&6 stock)

USA landings of pollock (*Pollachius virens*) decreased from 7,206 mt in 2011 to 6,732 mt in 2012. Autumn research vessel survey indices reflected a moderate increase in pollock biomass in Subarea 5 from the mid-1990s through 2005 (Figure 6). The survey biomass index subsequently declined to a record-low of 0.22 kg/tow in 2009. Although the index increased in 2010 to 3.22 kg/tow, it has since declined to 1.64 kg/tow in 2012.

5. White Hake

Nominal USA landings of white hake (*Urophycis tenuis*) decreased by 4% from 2,897 mt in 2011 to 2,769 mt in 2012. Research vessel survey indices declined during the 1990s and increased in 2000 and 2001 due to good recruitment of the 1998 year class. The indices have been variable since 2001 (Figure 7).

6. Yellowtail Flounder

USA landings of yellowtail flounder (*Limanda ferruginea*) increased by 30% from 1,831 mt in 2011 to 2,377 mt in 2012. A large portion of that increase was due to landings from Div. 3N (654 mt). In addition, 90 mt of yellowtail flounder were discarded in Div. 3N bringing the total catch of yellowtail flounder in Div. 3N in 2012 to 744 mt. Research survey biomass indices in 2012 increased in all three United States yellowtail flounder stocks. In the Cape Cod-Gulf of Maine stock, survey biomass indices increased from 2.9 kg/tow in 2011 to 3.6 kg/tow in 2012. In the Southern New England-Mid Atlantic stock, the survey biomass index increased from 0.6 kg/tow in 2011 to 1.4 kg/tow in 2012. In the Georges Bank stock, the survey biomass index increased slightly from 2.45 kg/tow in 2011 to 2.52 kg/tow in 2012 (Figures 8-10).

7. Other Flounders

USA commercial landings of flounders (other than yellowtail flounder and Atlantic halibut) from Subareas 3-6 in 2012 totaled 11,039 mt, 7% lower than in 2011. Summer flounder (*Paralichthys dentatus*) (54%),

winter flounder (*Pseudopleuronectes americanus)* (22% comprising the Georges Bank, Southern New England, and Gulf of Maine stocks), American plaice (*Hippoglossoides platessoides*) (14%), witch flounder (*Glyptocephalus cynoglossus*) (10%), and windowpane flounder (*Scophthalmus aquosus*) (<1% comprising the Northern and Southern stocks) accounted for virtually all of the 'other flounder' landings in 2012. Compared to 2011, commercial landings in 2012 were higher for witch flounder (19%), winter flounder (12%), and American plaice (11%) but lower for summer flounder (-19%) and windowpane flounder (-3%). The increase in American plaice landings was due to landings from Div. 3N (69 mt). In addition, 55 mt of American plaice were discarded in Div. 3N bringing the total catch of American plaice in Div. 3N in 2012 to 124 mt. Discards of with flounder in Div. 3N were low (1 mt). Research vessel survey indices in 2012 remained similar to the previous year's indices for summer flounder, witch flounder, Georges Bank winter flounder, and northern windowpane but decreased for American plaice (Figures 11-15).

8. Atlantic halibut

USA landings of Atlantic halibut (*Hippoglossus hippoglossus*) in the Gulf of Maine-Georges Bank region increased slightly from 26 mt in 2011 to 29 mt in 2012. In addition, 7 mt of halibut were discarded in NAFO Div. 3N. Research vessel survey indices have little trend and high interannual variability due to the low capture rate of Atlantic halibut. In some years, no Atlantic halibut have been caught in the survey indicating that halibut abundance was at or below the survey's detectability level. Indices for 2009 – 2012 were converted from H.B. Bigelow units to Albatross IV units using the mean calibration coefficient of other flounders.

9. Silver hake

USA landings of silver hake (*Merluccius bilinearis*) increased from 7,761 mt in 2011 to 8,206 mt in 2012. Research vessel survey biomass indices for the Gulf of Maine - Northern Georges Bank stock varied without trend between 1985 and 1997, sharply increased in 1998, and then declined through 2005. The indices then increased, with the 2010 index (13.4 kg/tow) the highest since the mid-1990s. Survey biomass indices for the Southern Georges Bank - Mid-Atlantic stock increased between 2007 and 2010, with the 2010 survey biomass index (2.8 kg/tow) the highest since the early 1980s (Figure 17-18). However, survey indices for both stocks declined in 2011. [WHY IS THERE NO MENTION OF 2012 INDICES?]

10. Red Hake

USA landings of red hake (*Urophycis chuss*) increased by 53% from 595 mt in 2011 to 912 mt in 2012. Research vessel survey biomass indices for the Gulf of Maine - Northern Georges Bank stock increased after the early 1970s, markedly declined in 2002-2003, and have since stabilized (Figure 19). Indices for the Southern Georges Bank - Mid-Atlantic stock declined in the 1980s, remained low through 2006 (Figure 20), but have since increased.

11. Atlantic Herring

Nominal preliminary USA landings of Atlantic herring (*Clupea harengus*) increased 10% from 79,779 mt in 2011 to 88,046 mt in 2012. Spring survey indices were relatively stable during 2005-2012 and averaged 2.23 kg/tow (Figure 21). The 2012 spring survey index was 1.69 kg/tow. Based on a 2012 assessment, spawning biomass generally increased from 1982 to 1997, declined from 1998 to 2009, and increased through 2011. The 2008 year class was estimated to be the largest on record. The 2012 assessment included several features not included in previous herring assessments, including multiple fleets, time-varying maturity, and time varying-natural mortality. These features combined to produce an assessment with relatively no retrospective pattern compared to previous herring assessments.

12. Atlantic Mackerel

USA commercial landings of Atlantic mackerel (*Scomber scombrus*) increased from 533 mt in 2011 to 5,332 mt in 2012. However, 2012 commercial landings were lower than in 2010 (9,877 mt). Recreational catches decreased from 932 mt in 2011 to 740 mt in 2012. Spring survey indices increased during the 1990s, averaged 9.5 kg/tow during 2001-2011, but declined to 4.4 kg/tow in 2012.

13. Butterfish

USA landings of butterfish (*Peprilus triacanthus*) declined from 662 mt in 2011 to 627 mt in 2012. Autumn research vessel survey biomass indices have fluctuated substantially since the 1970s, but were generally highest in the late 1970s to early 1990s. The survey biomass index increased markedly between 2008 and 2011, but declined sharply in 2012 (Figure 23).

14. Squids

USA landings of longfin inshore squid, *Doryteuthis (Amerigo) pealeii*, increased from 9,556 mt in 2011 to 12,720 mt in 2012, the highest catch since 2006. Autumn survey abundance indices, (derived using only daytime tows) declined from a near-record high of 1,778 squid/tow in 2006 to 338 squid/tow in 2011 but increased in 2012 to 1,371 squid/tow, which is well above the time series median (Figure 24).

USA landings of northern shortfin squid (*Illex illecebrosus*) declined 38% between 2011 and 2012, from 18,797 mt to 11,709 mt, respectively. Autumn survey abundance indices attained a record-high in 2006 (29.5 squid/tow), declined to 7.3 squid/tow in 2011, but increased slightly in 2012 to the time series median of 8.0 squid/tow (Figure 25).

15. Atlantic Sea Scallops

USA Atlantic sea scallop (*Placopecten magellanicus*) landings in 2012 were 25,750 mt (meats), slightly less than 2011, but more than double the long-term (1957-2009) mean. The ex-vessel value of the landings was about $555 million, also slightly less than in 2011. About 53% of the 2012 landings were from the Georges Bank region, 45% were from the Mid Atlantic Bight, and the remainder taken in Southern New England and the Gulf of Maine. This is the first year since 2006 that a majority of the landings were from Georges Bank. The shift of the fishery towards Georges Bank is reflective of strong 2007 and 2008 year-classes entering the fishery on Georges Bank, whereas these year classes are weak in the Mid-Atlantic Bight.

Stratified mean research vessel survey biomass indices decreased in 2012 in both the Georges Bank and Mid-Atlantic regions. However, these indices are still high by historical standards (Figures 26 and 27). Very strong recruitment, consisting of both the 2010 and 2011 year classes, is evident in the Mid-Atlantic Bight, while recruitment on Georges Bank is below average.

16. Northern Shrimp

Preliminary USA commercial landings of northern shrimp (*Pandalus borealis*) from Subarea 5 in 2012 were 307 mt, about 10% of the 2011 landings and the lowest since the fishery closure in 1978. Only about half of the TAL for 2012 was landed. The average landings for 2006-2010 were 4,184 mt, and the highest annual landings of northern shrimp were 12,824 mt in 1969.

The joint state-federal summer research vessel (R/V *Gloria Michelle*) survey biomass indices declined during 1985 through 2004. A sharp increase occurred in 2006 reflecting a strong 2004 year class; however, the 2006 survey was considered less reliable in part due to a reduced number of tows. Biomass indices subsequently fluctuated around a lower level during 2007-2011 (mean 13.2 kg/tow), but the 2012 biomass, abundance, and recruitment indices were record-lows. This stock is thought to be highly sensitive to ocean temperatures, which were unusually high in 2012.

17. Small Elasmobranchs

USA landings of spiny dogfish (*Squalus acanthias*) increased from 9,480 mt in 2011 to 10,660 mt in 2012. Survey indices, which are highly variable, generally declined between the early 1990s and 2005, but increased sharply in 2006 and have since remained high (Figure 29).

USA landings of skates (most species are still landed as unclassified) increased slightly between 2011 and 2012 from 16,287 mt to 16,857 mt. The landings are sold as wings for human consumption and as bait for the lobster fishery. In addition, 10 mt of skate were discarded in NAFO Div. 3N. Survey biomass indices for winter skate (*Leucoraja ocellata*) peaked in the mid-1980s (Figure 30) but then declined, possibly due to an increase in the directed fishery in the late 1980s and early1990s. During the mid-1990s, the indices stabilized at an intermediate level, increased through 2009, but have since declined. Little skate (*Leucoraja erinacea*) survey indices have generally fluctuated without trend (Figure 31). Survey indices for barndoor skate (*Dipturus laevis*) declined markedly in the mid-1960s, remained very low through the late-1980s, and subsequently increased to levels observed in the mid-1960s (Figure 32). Thorny skate (*Amblyraja radiata*) survey indices have declined over the entire time series, and are currently at record lows (Figure 33). Survey indices for smooth skate (*Malacoraja senta*) are highly variable, but have been generally stable for the last 20 years (Figure 34). Indices for both clearnose skate (*Raja eglanteria*) and rosette skate (*Leucoraja garmani*) generally increased over the time series (Figures 35 and 36). The indices for clearnose skate declined between 2001 and 2006, but sharply increased in both 2007 and 2008.

B. Special Research Studies

1. Environmental Studies

a) Hydrographic Studies

A total of 1,893 CTD (conductivity, temperature, depth) profiles were collected and processed during 12 cruises conducted by the Northeast Fisheries Science Center (NEFSC) cruises in 2012. Of the total CTD profiles 1,835 were obtained in NAFO Subareas 4, 5, and 6. These data are archived in an oracle database. Cruise reports, annual hydrographic summaries, and data are accessible at: http://www.nefsc.noaa.gov/epd/ocean/MainPage/index.html.

Hourly temperature records obtained by participants of the Environmental Monitors on Lobster Trap Project (see emolt.org) at approximately 70 fixed locations/depths around the Gulf of Maine and Southern New England Shelf indicate that 2012 was the warmest year since the project began in 2001. Early 2013 records provide evidence of continued warm conditions. Eighty-five satellite-tracked surface drifters were deployed off the coast of New England in 2012, and dozens more are planned for 2013 (see http://www.nefsc.noaa.gov/drifter). The collective archive helps resolve the transport pathways of estuarine and shelf waters.

b) Plankton Studies

During 2012, zooplankton community distribution and abundance were monitored using 734 bongo net tow samples taken on six surveys. Each survey covered all or part of the continental shelf region from Cape Hatteras northeastward through the Gulf of Maine. Additional sampling was also conducted done on one of these cruises by NASA and Old Dominion University scientists to "ground truth" satellite data with ship-based water column measurements. Data from these cooperative cruises is used to enhance the application of ocean color remote sensing to coastal ecosystems, and to derive region-independent ocean color algorithms for measuring primary productivity, particulate organic carbon, and dissolved organic carbon. Three of the six cruises collected nutrient data. This was done in collaboration with the University of Maine to monitor levels of nutrients in the euphotic zone. Nitrogen stable isotope ratios of particulate matter were measured for an EPA-led study on the distribution of these isotopes across the northeastern continental shelf. Four surveys also collected additional plankton samples for the Census of

Marine Zooplankton Program, based at the University of Connecticut. These samples, collected with a set of smaller bongo nets, are for genetic analysis of the plankton samples, to supplement identifications made by traditional visual taxonomic means. In addition to the research vessel surveys conducted, samples were collected by the Ship Of Opportunity Program, SOOP, using the container vessels Reykjafoss and Oleander. The Reykjafoss conducted thirteen transects between Boston and Halifax, one every month and two in December. The Oleander conducted ten monthly transects between New York and Bermuda, missing only June and November coverage. Samples were collected by the container vessels using a Hardy Plankton Recorder.

c) Benthic Studies

A ten day cruise was conducted during January, 2012 for the purposes of training students in the NOAA Living Marine Resources Cooperative Science Center (LMRCSC) in fisheries science, including learning field sampling procedures, and in support of projects being conducted by faculty and graduate students in the LMRCSC program. Scientific objectives included:

1) An examination of latitudinal variation in habitat and fish assemblages with a particular eye toward detecting Carolinian fauna making inroads into the Virginian faunal province as an indicate for climate change, 2) Investigating spatio-temporal patterns in demersal-megabenthic habitats on the shelf and slope around Hudson Canyon, and 3) Exploration on the continental slope to define depth limits of monkfish distribution and the biological condition of the deep sea red crab stock throughout the mid-Atlantic region, with an additional mission to collect live deep sea corals for culture in the laboratory with possible use in ocean acidification work at Sandy Hook.

Scientific observations included the following:

- Water temperatures were the highest seen since these cruises began in 2005 throughout the water column shelf-wide and in the upper water column over the slope at all latitudes.
- A pattern continues to emerge on the shelf and slope in which a background of resident species appear consistently in particular habitats year-to-year while others, largely seasonal migrants, do not appear to make use of those habitats in a consistent manner, even in the same season. Data of all types from this and other cruises is being assembled into a habitat model to try to understand factors governing the distribution of resource stocks around this canyon.
- An association between overwintering black sea bass, sponges, and sea scallops was suggested by the distribution of catches of those species off Maryland and Virginia.
- Dense patches of deepwater corals (the solitary cup coral *Dasmosmilia lymani*) and sponges continue to persist around the rim of Hudson Canyon. These data are currently being incorporated into habitat suitability models for these structural species and habitat maps for the canyon.
- Persistence of *D. lymani* has made it possible to collect specimens reliably in a blind beam trawl at Hudson Canyon and keep them alive until they could be transferred to a rearing facility at the Long Island (Atlantis) Aquarium in Riverhead, Long Island, New York. Our collaborators at the Aquarium have thus far been successful in feeding *D. lymani* specimens and maintaining them in good condition for the 2 months since the cruise. These and their progeny may be used for biological studies of this species. This is one of only two known successes in the U.S. in rearing deep sea corals.
- A dataset continues to be developed by which to assess year-to-year changes in biota shelf-wide based on a combination of sampling methods taken on a grid of fixed, geographically widespread sites on the mid-Atlantic shelf (the Latitudinal Transects). This includes a near-synoptic assessment of hydrological climate that drives migratory patterns in large part. Subject to further development and critical review, this could serve as the basis for a direct biological indicator of fisheries ecosystem state.
- For the fourth year (2008, 2009, 2011, 2012), substantial numbers of juvenile southern white shrimp were taken on the shelf off Virginia; their progression northward should be monitored both as a possible indicator of climate change and for its potential commercial importance. Other rare Carolinian species caught in smaller numbers include the horned whiff (small flatfish) and a macrurid (grenadier) known primarily from Florida waters. The long-spined sea urchin caught in two previous years was not seen.

- Monkfish (140 count) were caught at depths ranging from 100 to 868 m. Samples were taken for genomic analysis at the University of Maryland Eastern Shore. They occurred in deepwater otter trawls from all four deepwater slope and canyon areas and in some shelf samples taken by beam trawl in the Hudson Canyon vicinity. None were taken on the Maryland-Virginia shelf, as they had been in January, 2011.
- High densities of deep sea red crab (exceeding 105 individuals/km2) and witch flounder (approaching 104/km2) were estimated from deepwater trawls. Both species were present at all four slope/canyon areas; deep sea red crabs were dominant in all cases.

2. Biological Studies

a) Fish Species

Flatfishes: We are currently experimentally analyzing the responses of winter flounder, *Pseudopleuronectes americanus*, and summer flounder, *Paralichthys dentatus*, to the separate and joint effects of increased CO2 and water temperature during their early life-history. The effects of high CO2 oceans on finfish are largely unknown. The limited evidence to date supports the expectations that these effects will differ across species, will be subtle, and will interact with other stressors. These expectations demand a carefully planned, strategic approach in order to efficiently obtain information of value to resource managers. The team of researchers at the NOAA NMFS Howard Laboratory (Highlands, New Jersey), along with collaborators within the Northeast Fisheries Science Center and in academia, are implementing an experimental approach designed to cast an extensive yet strategic inferential net. The key elements of this broad yet adaptive approach are that it uses i) multiple species that differ in their ecologies and resource values, ii) a wide yet realistic range of environmental conditions (i.e., concurrent manipulation of CO2 levels and water temperatures), and iii) a diverse set of response variables. The research team has grown by bringing in colleagues and collaborators with different skill sets with respect to the set of biotic response variables to include a range of viability, physiological, morphometric, and behavioral responses of the early life-stages of our test species. Those colleagues are from Rutgers University, New York University, and University of New Hampshire. To date, we have run experiments up to one month in duration on the earliest life-stages of both species, including studies on gametes, embryos, and larvae. Responses scored or to be scored are viability, survival, developmental rate, growth rate, histological changes, otolith allometry, and various biochemical measures of fish condition. Early results for summer flounder (our first experiment) show a significant negative effect of increased CO2 on embryo survival and on larval growth and development. Embryo mortality increases with CO2 and larvae are initially larger, develop more quickly but metamorphose as smaller sizes at high CO2 levels. Further assays and new experiments will be conducted during 2013 on both species. We anticipate that black sea bass, *Centropristis striata*, and one or two local estuarine forage fish species will be the next species in our experiment queue. The results will aid researchers and resource managers in identifying which species types, life-stages, and biotic responses are most vulnerable to the expected future conditions in CO2 and water temperature in our oceans.

Gadids: Field and laboratory research continues on Atlantic tomcod, *Microgadus tomcod*, a locally abundant inshore gadid of the Northeastern USA and Eastern Canada. Tomcod has a 1-yr life cycle, is an important forage fish, and serves as a sentry of habitat and fish community health in the Hudson River Estuary (New York / New Jersey, USA). Two concurrent projects on tomcod are underway that address ecological and toxicological themes. Regarding the ecological theme, estimates are being obtained for: 1) maternal effects on offspring quality; 2) ontogenetic rates of eggs, larvae, and juveniles; 3) time of settlement, behavioral transitions with respect to habitat structure, and movement of juveniles in nature; and 4) risk of predation. Regarding the toxicological theme, three source populations – Hudson River, Shinnecock Bay (Long Island, New York) and Miramichi River (New Brunswick, Canada) that differ in contaminant histories are being compared with respect to: 1) uptake and depuration rates of dioxin and locally occurring (Hudson River) congeners of PCBs; 2) sublethal toxic responses to graded doses of local PCBs congeners using captive (F1 and F2) tomcod populations; and 3) interactions between environmental stressors, i.e., PCBs and high summer temperatures. We are also assessing the combined effects of PAHs and PCBs on ecologically relevant toxic endpoints, and estimates of toxicities of individual congeners

(PCB 77, 81, 126, and 169). We are analyzing responses in the adult stage after a 13-mo grow-out period. Some of our results from these studies include evidence of a single-gene mutation allowing resistance to dioxin-like compounds which were recently summarized in Science (331: 1322-1325).

Atlantic cod: The cod monitoring project is currently investigating array recordings collected in 2012 near a known Gloucester spawning ground in conjunction with the Department of Marine Fisheries. These data will be compared with data collected at the same site in 2011 to investigate temporal changes in cod presence and explore cod small-scale movement in more detail using passive acoustics. In addition, source level estimations and detection radius for cod spawning vocalizations will be obtained as part of this project. Additionally, information from this project will be used to scan existing passive acoustic datasets in Massachusetts for cod presence and potentially discover unknown spawning aggregations.

Sturgeons: We have conducted several pilot eco-toxicological studies on shortnose and Atlantic sturgeons (*Acipenser brevirostrum* and *A. oxyrhynchus*, respectively). Toxic responses of eggs and larvae were evaluated after aqueous exposures to PCB 126 and TCDD. Rates of uptake of radiolabelled PCB126 were also quantified. Responses evaluated to date include viability, macro-phenotypic characters (e.g., days to hatch, morphometrics of recently hatched larvae, and starvation resistance), and molecular responses (CYP1A1). Uptake was a linear function of exposure doses, and toxicity was expressed in both species to both contaminants in lethal and sublethal responses including survival of early life-stages, the size and shape of larvae, and the development of key organs. These results are summarized in Chambers et al. (2012) (Chambers, R.C., D.D. Davis, E.A. Habeck, N.K. Roy, and I. Wirgin, 2012. Toxic effects of PCB126 and TCDD on shortnose sturgeon and Atlantic sturgeon. Environmental Toxicology and Chemistry 31:2324-2337.

b) Resource Survey Cruises

During 2012, personnel from the Ecosystems Surveys Branch (ESB) staged, staffed, and supported the spring and fall multi-species bottom trawl survey and the northern shrimp trawl survey. Additional staff and gear support was provided for the sea scallop and surfclam/ocean quahog dredge surveys, and the Atlantic herring hydroacoustic survey. In aggregate, the survey staff efforts totaled 201 research and charter vessel sea days. NOAA scientific and contract staff involvement in the various cruises totaled of 1,978 person sea days, and volunteers contributed another 454 person sea days. ESB cruises occupied 1,404 stations in an area extending from Cape Hatteras, North Carolina to Nova Scotia. A total of 2,525,947 length measurements were recorded from 313 species during these cruises. Ecosystem survey data are used as fishery independent inputs for 48 single species stock assessments and for several ecosystem dynamics modeling efforts.

Significant effort was also expended in 2012 to fulfill special survey sampling requests from 29 NOAA and University investigators. This sampling included 18,445 feeding ecology observations, collection of 33,202 aging structures, and acquisition of 17,769 samples/specimens to support additional shore-based research.

c) Age and Growth

Fishery Biology Program contributes to the basic understanding of species age and growth related demography and ecology, and integrated ecosystem research plans in the Gulf of Maine and Georges Bank area. In 2012, the Program provided ages on nearly 60,000 otoliths and other hard structures from over 15 species. In addition to Atlantic cod (12,167), haddock (9,421), and yellowtail flounder (7,175), 7,468 white hake, 3,600 winter flounder, and 3,463 summer flounder were aged. Age determinations for butterfish, scup, witch flounder and black sea bass totaled 10,564. Most otoliths and other hard part structures are read for production ages that support age-structured stock assessments that serve as the basis for scientific advice to the NEFMC. These data provide information on age compositions, recruitment strength and growth dynamics which ultimately inform the scientific basis for determination of stock status, biological reference points and annual catch limits.

The Program implements a set of robust QA/QC protocols to monitor and maintain 1) accuracy and 2) precision in age determinations.

1) Accuracy: Through the use of reference collections, personnel each year determine if any bias or deviation of their age estimates occurs compared to the previous years. The Fishery Biology Program also partners with other agencies by exchanging age structures. In 2012, haddock, cod, and winter flounder age structures were exchanged with age readers from the St. Andrews Biological Station (Fisheries and Oceans Canada) and the Massachusetts Department of Marine Fisheries to maintain age determination comparability among laboratories.
2) Precision: A subsample of specimens is re-aged blindly by personnel to assess deviation from 1:1 equivalence. A test of symmetry is used to detect any systematic differences between the original ages and the random test. If the coefficient of variation is under 5%, the ages are considered precise.

Related research.- Research projects in 2012 included:

(1) initiated a project on white hake life history, in partnership with the State of Maine;
(2) continued enhanced biological sampling selected fishes to examine fecundity dynamics;
(2) continued calibration of macroscopic gonad staging performed during research vessel survey cruises as validated by an independent, gonad histology method;
(3) continued analysis of environmental effects on haddock growth and reproduction;
(4) continued to investigate the feasibility of measuring bioelectrical impedance (BIA) as a predictor of fish condition and reproductive potential;
(5) continued a reproductive study of maturation, sex change, and reproductive seasonality of the migratory black sea bass population from the mid-Atlantic states and southern New England;
(6) completed ageing summer flounder by sex from samples collected in both the recreational and commercial fleets, and the data were entered for use in the next assessment (June, 2013);
(7) completed ageing of Atlantic surfclams to validate a sectioned chondrophore method at three latitudes, across this species' geographic range (manuscript in prep.);

d) Food Web Dynamics

The NEFSC continued studies of fish trophic dynamics based on an integrated program of long-term (since 1973) monitoring and process-oriented predation studies. Modeling and analytical efforts focused on species interactions among small pelagics, flatfish, elasmobranchs, and gadiformes.

Food habits samples were collected on the northeastern U.S. and Mid-Atlantic continental shelf during NEFSC spring and autumn surveys. Estimates of prey volume and composition were made at sea for selected species. During the 2012 spring and autumn surveys, 10,237 stomachs from 56 species, and 8,538 stomachs from 55 species were examined respectively. Diet sampling emphasized gadiformes, elasmobranchs, small pelagics, flatfishes, and lesser known species.

The 40 year time series (1973-2012) of food habits data collected during NEFSC bottom trawl surveys continued. The majority of the time series is now available for analysis, including data from over 565,000 stomach samples and over 160 predators. The processing of the 2012 bottom trawl survey food habits data is scheduled for completion in 2013.

Diet data undergo two rigorous data quality audits including initial checks at sea during sample collection and secondary checks in the lab to ensure data quality. These checks consider the various facets of prey taxonomy, predator/prey mass, predator/prey length, and prevent missing information. During 2004-2011, stomach contents regularly processed at sea were preserved from every 25th station. These samples were processed in the laboratory as an additional form of data quality control.

Since 2004, training workshops for identifying fish stomach contents and refreshing staff knowledge of marine invertebrate and fish taxonomy have been offered regularly throughout the year (approximately six

times). These workshops provide class discussions and freshly caught specimens as aids for prey identification in association with the spring and autumn groundfish cruises.

Staff prepared several papers and reports for publication on a wide range of trophic ecology issues in the Northwest Atlantic ecosystem. Since trophic interactions are central to food web and ecosystem considerations, research continues with respect to essential fish habitat, fish production, incorporating fish consumption into stock assessments, and evaluating fisheries reference points.

e) Apex Predators Program

Apex Predators research focused on determining migration patterns, age and growth, feeding ecology, and reproductive biology of highly migratory species, particularly large Atlantic sharks. Members of the Cooperative Shark Tagging Program, involving over 7,000 volunteer recreational and commercial fishermen, scientists, and fisheries observers, continued to tag large coastal and pelagic sharks and provide information to define essential fish habitat for shark species in US waters in 2012. Information was received on 4,200 tagged and 575 recaptured fish bringing the total numbers tagged to 235,000 sharks of more than 50 species and 14,200 sharks recaptured of 33 species.

Staff participated in the SEDAR Data Workshop for the assessment of the Gulf of Mexico blacktip shark population. A working paper was presented during the workshop summarizing blacktip shark mark/recapture data from the Cooperative Shark Tagging Program. These data were pivotal in determining the need for multiple (Gulf of Mexico and U.S. Atlantic) stock assessments for this species.

The NEFSC Coastal Shark Bottom Longline Survey of Atlantic large and small coastal sharks, started in 1986 and conducted every two to three years, is the longest fishery-independent shark survey in the U.S. Atlantic Ocean. Its primary objective is to conduct a standardized, systematic survey of the shark populations off the U.S. Atlantic coast to provide unbiased indices of relative abundance for species inhabiting the waters from Florida to the Mid-Atlantic. Results from the 2012 survey included 1,845 fish (1,831 sharks) representing 16 species, of which 1,564 (85%) were tagged and released. These totals were higher than in any previous survey. Sharks represented 99.2% of the total catch of which sandbar sharks were the most common, followed by dusky and tiger sharks.

The NEFSC Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) survey continued to investigate known and putative shark nursery areas along the US east coast to describe their species composition, habitat preferences, and determine the relative abundance, distribution and migration of sharks through longline and gillnet sampling and mark-recapture data. In 2012, our COASTSPAN participants were the Massachusetts Division of Marine Fisheries (MDMF), Stony Brook University, Virginia Institute of Marine Science, North Carolina Division of Marine Fisheries, South Carolina Department of Natural Resources, Georgia Department of Natural Resources, and the University of North Florida. MDMF staff also conducts a survey in the U.S. Virgin Islands using COASTSPAN gear and methods. The NEFSC staff conducts the survey in Narragansett and Delaware Bays. Over 4500 sharks of 15 species were caught during COASTSPAN surveys, more than 2000 (45%) of these sharks were tagged for migration studies, and 140 of these sharks were double tagged for a tag retention study. A Ph.D. dissertation from the University of Massachusetts School for Marine Science and Technology was completed using COASTSPAN supported research with passive acoustic telemetry in Massachusetts waters to study the habitat utilization and essential fish habitat of juvenile sand tigers. These results were published in December of 2012 in Marine Ecology Progress Series.

Since 1961, recreational shark tournament sampling has been conducted annually during the summer from New Jersey to Maine. Tournaments are a primary source of biological samples used in NEFSC shark food habits, reproduction, and age/growth studies that provide biological reference points used during the ICCAT pelagic shark assessments and SEDAR process. APP staff also conducts fishery-dependent investigations of pelagic nursery grounds in conjunction with the high seas commercial longline fleet. This collaborative work involves sampling and tagging blue sharks and shortfin makos in a potential nursery area, and collecting length-frequency data and biological samples. Thus far over 3,000 sharks have been

tagged and over 225 recaptured; the recaptures are primarily blue sharks recovered by commercial fishermen working in the mid-Atlantic. To date, 500 blue sharks have been double tagged using two different tag types to help evaluate tag-shedding rates, which are used in sensitivity analyses of population estimates and to estimate blue shark fishing mortality and movement rates.

The NEFSC Cooperative Research and Apex Predators Programs launched a cooperative initiative to tag spiny dogfish in the Gulf of Maine, Southern New England, and Georges Bank using three commercial vessels. This project is an effort to answer long-standing questions about stock structure, movement patterns, and life history of the species in order to update and improve dogfish stock assessments. Over a two-year period (2011-2012), 34,604 spiny dogfish were tagged and 488 of these sharks have been recaptured to date. Some tagged dogfish were injected with oxytetracycline (OTC) for an age validation study. A total of 91 fish that were OTC injected have been recaptured and returned to the APP for age validation and 72 of these fish were in good enough condition to obtain measurements for reproductive studies.

f) Marine Mammals

In 2012, NEFSC continued work on the Atlantic Marine Assessment Program for Protected Species (AMAPPS), which is a partnership with the Bureau of Ocean Energy Management, the US Navy, and the US Fish and Wildlife Service. As part of this program, NMFS is conducting seasonal surveys of protected species along the Atlantic coast through the next several years. The goal of the program is to provide a better understanding of the distribution and abundance of sea turtle, marine mammal, and seabird populations, and to develop a decision-support tool for use in evaluating the likely impacts of various industrial, military, and development activities within U.S. Atlantic waters.

Small Cetaceans:

During 28 March – 3 May 2012 and 17 October – 16 November 2012, as part of the AMAPPS project the NEFSC conducted aerial abundance surveys of marine mammals and sea turtles using the NOAA Twin Otter aircraft. The southwestern extent of both surveys was New Jersey. The northeastern extent of the spring survey was the southern tip of Nova Scotia, Canada, and was waters off Halifax, Nova Scotia, Canada for the fall survey. Both surveys covered waters from the coast line to about the 2000-m depth contour. Track lines were flown 183 m (600 ft) above the water surface, at about 200 kph (110 knots). The two-independent-team method was used to collect the data. In Beaufort sea states of 4 and less, about 6800 km of on-effort track lines were surveyed in the spring survey and about 7100 km in the fall survey. During spring, over 700 individuals within over 200 groups of 14 identifiable species of cetaceans, seals and fish were detected. The most regularly detected small cetacean species were white-sided dolphins (*Lagenorhynchus acutus*), bottlenose dolphins (*Tursiops truncatus*) and harbor porpoises (*Phocoena phocoena*); fin whales *(Balaenoptera physalus*) were the most common large whale. No sea turtles were detected. During fall, over 1600 individuals within over 150 groups of 14 species of identifiable cetaceans, 3 sea turtle species, 1 identifiable seal species, and three fish species were detected. The most regularly detected small cetacean species were common dolphins (*Delphinus delphis*), white-sided dolphins and bottlenose dolphins; the most common large whales were humpback whales (*Megaptera novaeangliae*), fin whales and minke whales (*Balaenoptera acutorostrata*); and the most common turtle was the loggerhead turtle (*Caretta caretta*).

Incidental bycatches of cetacean, turtle, and pinniped species were estimated based on observed takes in commercial fisheries from Maine to North Carolina. Fisheries observed during 2012 included gill nets, otter trawls, mid-water otter trawls, mid-water pair trawls, scallop trawls, shrimp trawls, scallop dredges, clam dredges, purse seines, beach anchored gillnets, bottom longline, pound nets, and some pot and traps. Cetaceans observed taken included harbor porpoises, Risso's dolphins (*Grampus griseus*), common dolphins, Atlantic white-sided dolphins, and bottlenose dolphins. To support Atlantic Take Reduction Teams (e.g., harbor porpoise, coastal bottlenose dolphin, and Atlantic trawl teams), the observer data were analyzed to identify environmental factors, fishing practices, and gear characteristics associated with the bycatches.

Large Cetaceans:

Three shipboard North Atlantic right whale (*Eubalaena glacialis*) cruises were completed in 2012, one during 14–29 March aboard the NOAA R/V Delaware II, the second from 30 April to 25 May also aboard the NOAA R/V Delaware II, and the third on the NOAA R/V Henry Bigelow during 18–28 June. Primary cruise activities included: (1) collecting biopsies and photographs of North Atlantic right whales; (2) acoustic recording minke, sei (*Balaenoptera borealis*) and fin whales; (3) conducting CTD casts to examine oceanographic changes. (4) conducting zooplankton sampling to examine prey sources; (5) collecting right whale fecal samples for hormone analysis; and (6) retrieving marine acoustic recording units (MARU). The primary areas of operations were the Great South Channel, Georges and Franklin Basins, Stellwagen Bank, Rhode Island Sound, extended to the Northeast Channel in Canadian waters.

The North Atlantic Right Whale Sighting Survey (NARWSS) is a NOAA Fisheries program that locates and records the seasonal distribution of North Atlantic right whales off the northeastern coast of the United States. NARWSS flights conducted in 2012 followed systematic track lines with randomized starting locations within 11 primary survey boxes: Cashes Ledge, Franklin Basin, Georges Basin, Georges Shoal, Great South Channel, Howell Swell, Jeffreys Ledge and Wildcat Knoll, Jordan Basin and Jeffeys Bank, Lindenkohl Basin and Truxton Swell, Stellwagen Bank and Wilkinson Basin, and Rhode Island Sound (Figure 1). During 2012, NARWSS flew 275 hours on 64 surveys including a survey of Roseway Basin and a directed survey to search for 2 mother-calf pairs reported south of Long Island NY. NARWSS detected 279 right whales (including repeats of the same individual), with 270 right whales sighted within survey blocks and 9 right whales sighted during transit to or from survey areas. No right whales were sighted on Roseway Basin or south of Long Island.

During January-March 2012, skin samples were collected from right whales on the calving grounds in the coastal region (<25 nmi from land) between Savannah, GA and St. Augustine, FL. Whales were located by aerial spotting teams, and skin and blubber samples were obtained using biopsy darts deployed by crew in an inflatable boat. DNA in right whale skin can be used to determine sex, and to create a genetic "fingerprint" for later re-identification. These samples will be added to the extensive collection of right whale DNA (obtained from approximately 300 individual right whales) maintained at Trent University in Ontario, Canada. DNA collected and archived through the project will not only help researchers identify individual whales and their paternity, but also to: (1) assess genetic variation in the population; (2) determine how many females are reproductively active; (3) monitor the health of individual animals, and (4) better understand the right whale mating system.

Since 2007, and continuing through 2013, the NEFSC has been involved in an ocean noise project in the Stellwagen Bank National Marine Sanctuary. The objectives of this project are to map the ocean noise budget within the sanctuary, characterize various contributing noise sources (biological and anthropogenic), and to evaluate the noise impact on marine mammals in terms of their available communication range. Communication ranges are being modeled for four species of baleen whales (right, fin, minke, and humpback (*Megaptera novaeangliae*)) across six call types. The data analyses are expected to reveal the extent of loss of communication space of these whales under present-day noise conditions.

NEFSC researchers have also been working to: (1) elucidate the basic acoustic behavior of various marine mammal species; (2) monitor baleen whale presence using real time reporting from autonomous glider platforms; and (3) improve the application of passive acoustics as a tool for monitoring and mitigation.

In an ongoing project the acoustic behavior of right whale mother-calf pairs is investigated using a variety of different methods. This research is being conducted in collaboration with Dr. Susan Parks (Syracuse University). Fieldwork in the Bay of Fundy, Cape Cod Bay, and on the US Southeast calving grounds involves obtaining recordings using a towed hydrophone from a small boat.

Another project is exploring variation in right whale calling activity. Patterns and behavioral ecology at different spatial and temporal scales are being analyzed by locating individual right whales in the Stellwagen Bank National Marine Sanctuary area.

Minke whale call characteristics are being measured and described for the Massachusetts Bay area, and a geographical comparison of minke whale calls and their seasonal occurrence across the Western Atlantic is underway.

In addition, unknown pulsed calls which may be produced by humpback or minke whales and are prevalent in the summertime in the Stellwagen Bank Sanctuary, are being described in their physical characteristics and seasonal occurrence.

Using data collected on line-transect surveys, the acoustic properties of a previously not recorded beaked whale species (Sowerby's beaked whale (*Mesoplodon bidens*)) could be described for the first time.

A cetacean acoustic abundance estimation project is aimed at developing protocols for monitoring spatial and temporal trends in abundance. These protocols will be used to obtain absolute acoustic abundance estimates for cetaceans, and to integrate acoustic abundance estimates with visual abundance estimates from ship-board line-transect surveys, as well as longer-term stationary acoustic monitoring projects. The first target species for abundance estimation from line-transect surveys are sperm whales (*Physeter macrocephalus*). New point-sampling and spatially-explicit capture-recapture (SECR) methods will be used to investigate their feasibility for estimating the abundance of right whales.

A new collaboration with Dr. Mark Baumgartner at WHOI aims at developing adaptive, automatic detectors for baleen whale calls. These automatic detection methods will be used to explore, amongst others, passive acoustic data collected on Georges Bank in 2012, in order to gain a better understanding of the spring distribution of baleen whales in offshore Northeast waters.

In collaboration with Robert Valtierra from Boston University a new method for localizing low-frequency baleen whale calls using a single acoustic sensor has been developed. In addition a low-cost autonomous underwater recorder has been designed and tested in early 2013

An autonomous acoustic technology project using glider technology is underway with the Woods Hole Oceanographic Institution (WHOI) to: (1) record low and mid-frequency marine mammal vocalizations; (2) detect, classify, and remotely report vocalizations of interest; and (3) collect oceanographic data. Two gliders were deployed in the Outer Fall region in the central Gulf of Maine in November 2012, to study the behavior and prey species of baleen whales in this region, which due to adverse weather conditions in the wintertime remains poorly studied. Several baleen whale species, including North Atlantic right whales could be recorded and and glider information was used to direct dedicated aerial surveys for this highly endangered species. Data from the gliders are now being analyzed in more detail. A real-time moored buoy will be developed that can be deployed and relay back detections of baleen whales throughout its deployment period.

Scarification analyses of right and humpback whales continued in 2012. These analyses are used to monitor interactions between whales and fishing gear.

Work continued with the New England Aquarium and University of Rhode Island to update the North Atlantic Right Whale Individual ID catalogue and right whale sightings data bases.

Pinnipeds:

In 2012, four aerial seal surveys were conducted to monitor major gray seal (*Halichoerus grypus*) pupping colonies in Massachusetts and Maine coastal waters.

In a repeat of a project conducted in 2011, researchers from the NEFSC and several other institutions conducted harbor seal (*Phoca vitulina*) live-capture, tagging, and biological sampling operations between March and May 2012. The primary purpose of this work was to attach radio tags to seals to obtain a correction factor that could be used to account for the number of seals not hauled-out (therefore not available to be observed/counted) during aerial abundance surveys. This correction factor was applied to the raw seal counts obtained from NEFSC 27 May – 2 June aerial survey, conducted along the coast of

Maine, to estimate the total harbor seal population size. The survey timing coincided with the peak pupping period. A secondary objective was to collect health assessment and stock identification samples. Collaborating institutions included the Woods Hole Oceanographic Institution, International Fund for Animal Welfare, Riverhead Foundation for Marine Research and Preservation, Canadian Department of Fisheries and Oceans, Provincetown Center for Coastal Studies, University of Maine, Maine Department of Marine Resources, NOAA Northeast Regional Office, NOAA National Marine Mammal Laboratory, New England Aquarium and the University of New England Marine Animal Rehabilitation Center. Support for the project was provided by the AMAPPS program.

Another harbor seal capture effort was conducted in December 2012 in Moriches Bay, New York. The goal was to satellite and radio tag seals to study seal seasonal movements within an important southern New England wintering habitat, and spring dispersion to northern New England waters.

Bycatch estimation of harbor, gray and harp (*Pagophilus groenlandicus*) seals was conducted based on observed takes in the Mid-Atlantic Gillnet and Northeast Sink Gillnet fisheries.

g) Turtles

The NEFSC collaborated with academics, industry groups, and researchers from other NMFS science centers to (1) collect and assess data on sea turtles in U.S. Mid-Atlantic waters; and (2) reduce sea turtle bycatch in U.S. commercial fisheries in the Northwest Atlantic Ocean.

In 2012, the NEFSC undertook (or contracted) two gear and gear-related projects investigating methods to reduce sea turtle bycatch in fishing gear. These included: (1) a comparative study of the performance of a "topless trawl" on the targeted catch; and (2) continued refinement and investigation of the usefulness and capability of a tow time data logger to accurately record tow time in the bottom trawl fishery.

In 2012 the NEFSC completed or continued research projects related to turtle bycatch detection and assessment. Completed projects included: (1) predictive modeling of turtle encounter rates in the Mid-Atlantic using both fishery dependent and fishery independent data sources; (2) development of a method to estimate sufficient levels of observer coverage to monitor turtle bycatch events; (3) estimated turtle mortality rates in commercial gears using serious injury guidelines; and (4) estimated bycatch of turtles in Mid-Atlantic gillnet gear from 2007 to 2011. In addition, the NEFSC continues to develop quantitative methods for assessing anthropogenic threats to sea turtles.

In support of AMAPPS priorities, NEFSC and regional partners deployed satellite tags on wild-captured loggerhead sea turtles to monitor movements and behavior, and to collect information on diving and surfacing times to develop correction factors for the proportion of turtles underwater during aerial surveys (and therefore not observed during these surveys). Thirty-two satellite tags were deployed on loggerhead sea turtles collected in offshore and nearshore mid-Atlantic shelf waters.

h) Seabirds

Seabird abundance data were collected in 2012 on several NEFSC fish surveys, and seabird bycatch information was collected by observers on a sample of the commercial fishing trips. Seabird bycatch estimates are currently being analyzed.

3. Studies of Fishing Operations

In 2012, NEFSC Observers were deployed on 2,576 trips aboard commercial fishing vessels. The kept and discarded catch was weighed or estimated for all observed hauls. Estimated kept weights were obtained for all unobserved hauls. Length frequencies were recorded and age structures were collected from a portion of observed hauls. NEFSC Observers recorded 163 marine mammal incidental takes, 34 sea turtle incidental takes, and 716 seabird incidental takes. For most of these animals, the information recorded included animal condition, length and other relevant body measurements, as well as species identification

characteristics. Tissue samples were also collected from many of these animals, and the entire animal was collected if possible.

In addition, the Northeast Fisheries Observer Program deployed At-Sea Monitors on 2,578 trips aboard commercial fishing vessels in 2012. On these trips there were 161 marine mammal, five sea turtle, and 273 seabird incidental takes documented.

a. New England and Mid-Atlantic Sink Anchored Gillnet Fisheries

In the sink anchored gillnet fishery, 667 trips were observed with a total of 2,842 gear retrievals by Observers. There were 65 observed marine mammal takes in this fishery (22 gray seals, 18 harbor seals, 17 harbor porpoises, four common dolphins, one whitesided dolphin, one humpback whale, one unidentified seal, and one unidentified dolphin). There were also six loggerhead, one green, one leatherback and one unidentified hard-shell turtles and 217 seabird takes (160 of which were greater shearwater) observed in this fishery.

At-Sea Monitors observed 1,193 trips in the sink anchored gillnet fishery with 5,093 gear retrievals. There were 116 marine mammal (70 gray seals, 19 harbor porpoises, 18 harbor seals, five unidentified seals, three common dolphins, and one Risso's dolphin), three sea turtle (two unidentified hard-shell turtles and one Kemp's Ridley turtle) and 264 seabird (193 of which were greater shearwaters) incidental takes recorded in this fishery by Monitors.

b. Float Drift Gillnet Fishery

There were four floating drift gillnet trips with 16 gear retrievals observed in 2012. There were no marine mammal, sea turtle, or seabird takes observed.

No Monitors deployed on float drift gillnet trips in 2012.

c. Otter Trawl Fisheries

In the bottom otter trawl fishery 946 trips were observed with a total of 7,720 gear retrievals recorded by Observers. In addition, there were 34 midwater trawl trips with 96 gear retrievals, 19 scallop trawl trips with 180 gear retrievals, 19 shrimp bottom otter trawl trips with 69 gear retrievals, eight twin trawl trips with 129 gear retrievals, four haddock separator trawl trips with 121 gear retrievals and one Ruhle trawl trip and 36 gear retrievals observed in 2012.

In the bottom otter trawl fishery, there were 53 observed marine mammal takes (35 common dolphins, five whitesided dolphins, three harbor seals, two gray seals, two harbor porpoises, two pilot whales, one bottlenose dolphin, one Risso's dolphin, one unidentified dolphin, and one unidentified whale). There were also 22 loggerhead turtles, one green turtle, one unidentified hard-shell turtle, and ten seabird takes in this fishery. In the mid-water trawl fishery, there was one common dolphin take. In the scallop trawl fishery, no marine mammal, sea turtle, or seabird takes were observed. As well, no marine mammal, sea turtle or seabird takes were observed in the shrimp bottom otter trawl fishery. In twin trawl trips, there were two pilot whales, one common dolphin, and one Risso's dolphin takes observed. On haddock separator trawl and Ruhle trawl trips in 2012 there were no takes observed.

Monitors deployed on 1,176 bottom otter trawl trips with 11,861 gear retrievals, one Ruhle trawl trip with 30 gear retrievals, and 9 haddock separator trawl trips with 163 gear retrievals in 2012. There were 41 marine mammal (13 pilot whales, eight gray seals, seven common dolphins, five whitesided dolphins, four unidentified dolphins, two harbor porpoises, one harbor seal, and one unidentified seal), two loggerhead turtle, and six seabird takes recorded by Monitors in the bottom otter trawl fishery. Monitors also documented two gray seals and one common dolphin on haddock separator trawl trips in 2012. There were no takes documented on Ruhle trawl trips in 2012.

d. Sea Scallop Dredge Fishery

In the sea scallop dredge fishery, 429 trips were observed with a total of 43,295 gear retrievals. There was one harbor seal and 25 seabird takes observed in this fishery.

No Monitors deployed in the scallop dredge fishery in 2012.

e. Scottish Seine Fishery

No Scottish seine trips were covered by Observers or Monitors in 2012.

f. Sink Drift Gillnet Fishery

In the sink drift gillnet fishery in 2012, Observers were deployed on 135 trips with a total of 853 gear retrievals. There were seven seabird takes in this fishery.

Monitors deployed on 12 trips with a total of 75 gear retrievals. There were two takes (one harbor seal and one greater shearwater) documented in this fishery.

g. Anchored Floating Gillnet Fishery

There was one anchored floating gillnet trip with one gear retrieval observed in 2012. No marine mammal, sea turtle, or seabird takes were observed in this fishery.

No Monitors deployed on anchored floating gillnet trips in 2012.

h. Mid-water Pair Trawl Fishery

In 2012 there were 188 mid-water pair trawl trips observed with a total of 789 gear retrievals. One pilot whale, one gray seal, one harbor seal, and 108 seabird (79 greater shearwaters, 16 northern gannet, eight unidentified shearwater, two sooty shearwater, two unidentified seabirds, and one great black-backed gull) takes observed in this fishery. No sea turtles were documented.

No Monitors deployed on mid-water pair trawl trips in 2012.

i. Bottom Longline Fishery

In the bottom longline fishery in 2012, 40 trips were observed with a total of 145 gear retrievals. There were no marine mammal, sea turtle or seabird takes observed.

At-Sea Monitors covered a total of 146 bottom longline trips and 549 gear retrievals in 2012. There was one herring gull and one sooty shearwater documented in this fishery. No marine mammal or sea turtle takes were observed in this fishery in 2012.

j. Beach Haul Seine Fishery

No beach haul seine trips were covered by Observers or Monitors in 2012.

k. Pound Net Fishery

No pound net trips were covered by Observers or Monitors in 2012.

l. Handline Fishery

In 2012, there were seven handline trips observed with 45 gear retrievals and two auto-jig handline trips with 15 gear retrievals. No trolling trips were observed in 2012. No marine mammals or sea turtles were taken in this fisher. Two greater shearwater were observed in this fishery in 2012.

Monitors covered 39 handline trips and 334 gear retrievals and two auto-jig handline trips and 28 gear retrievals in 2012. There were no documented takes in this fishery in 2012.

m. Herring Purse Seine Fishery

In 2012, there were 54 herring purse seine trips with 117 gear retrievals observed. There were 33 gray seals, two humpback whales, one unidentified baleen whale, one harbor seal, 281 greater shearwaters, 64 unidentified shearwaters, and two unidentified seabirds observed in this fishery. No sea turtles were observed in this fishery.

No herring purse seine trips were covered by Monitors in 2012.

n. Menhaden Purse Seine Fishery

There were three menhaden purse seine trips with 11 gear retrievals observed in 2012. There were no incidental takes documented on these trips.

No menhaden purse seine trips were covered by Monitors in 2012.

o. Lobster Pot Fishery

In 2012, there were 15 lobster pot trips with 570 gear retrievals observed. There were no documented takes in this fishery.

No lobster pot trips were covered by Monitors in 2012.

p. Fish Pot Fishery
No fish pot trips were covered by Observers or Monitors in 2012.

q. Conch Pot Fishery

No conch pot trips were covered by Observers or Monitors in 2012.

r. Red Crab Pot Fishery

No red crab pot trips were covered by Observers or Monitors in 2012.

s. Clam Dredge Fishery

No clam dredge trips were covered by Observers or Monitors in 2012.

t. Scallop Beam Trawl Fishery

No scallop beam trawl trips were covered by Observers or Monitors in 2012.

4. Population Dynamics Research

a) Stock Assessments

Population dynamics research conducted within the NEFSC supports a number of domestic and international fisheries management authorities. Within the United States Northeast Region, management plans are developed by the New England (states of Maine through Connecticut) and Mid-Atlantic (New York through North Carolina) Fishery Management Councils, and the Atlantic States Marine Fisheries Commission (ASMFC). There are about three dozen managed species; all require stock status updates as a basis for fishery management. Stock assessments are routinely reviewed in a peer review process termed the Stock Assessment Workshop (SAW). Stocks assessments conducted and reviewed through this process in 2012 include Gulf of Maine cod, Georges Bank cod, Atlantic herring and Southern New England yellowtail flounder.

Not all assessments conducted by the NEFSC are vetted at the SAW. Some are developed and reviewed in the US/Canada Transboundary Resources Assessment Committee (TRAC). In 2012, stock assessments conducted and reviewed through the TRAC process included Eastern Georges Bank cod, Eastern Georges Bank haddock, and Georges Bank yellowtail flounder. Assessment updates, through a new process, were conducted for Georges Bank cod, Gulf of Maine haddock, Georges Bank haddock, Acadian redfish, Cape Cod/Gulf of Maine yellowtail flounder, American plaice, witch flounder, two stocks of windowpane flounder, ocean pout, Atlantic wolfish, and Atlantic halibut. Other stock assessments in 2012 vetted in regional bodies included summer flounder, scup, black sea bass, bluefish, spiny dogfish, striped bass, and Northern shrimp.

b) Atlantic Salmon Research

Atlantic salmon populations in eastern Maine are listed as endangered under the United States Endangered Species Act (ESA). Spawning populations have dwindled over the years, and both smolt escapement and ocean survival rates have declined. Research programs conducted by the NEFSC, in conjunction with various agencies, private partners and international collaborators, are designed to better understand the factors contributing to these declines. Research activities include a variety of projects in natal rivers, estuaries, and at sea. The data from these studies are used to provide information for local, national, and international stock assessment activities. These assessments support ESA and North Atlantic Salmon Conservation Organization (NASCO) management efforts.

Field research in 2012 focused on (1) a fish community survey within the Penobscot River estuary; (2) marine telemetry; (3) monitoring of fishery removals on the high seas; and (4) satellite tagging at Greenland. Through the application of active (pelagic trawling) and passive (multi-frequency split-beam hydroacoustics) techniques, estimates of biomass and habitat use for various commercially important fish species (e.g. Atlantic herring, alewife, blueback herring, American shad) are being developed for the Penobscot Estuary. Documentation of American shad spawning, the presence of multiple size classes of river herring utilizing the upper estuary and the detection of significant juvenile Atlantic herring biomass in the lower estuary highlights the importance of this estuarine nursery. Telemetry studies have identified significant mortality during the transition to the marine environment for both wild and hatchery-reared smolts. Zones of increased mortality have been identified, and potential causal mechanisms (poor physiological condition, predation, etc.) and evaluation of different hatchery products are being investigated through follow-up studies. Monitoring the West Greenland fishery and collecting biological data and fishery statistics continued. These data are provided directly to ICES and are required for North American run-reconstruction modeling and for developing catch advice for the fishery. Data collected from satellite tagging effort have provided novel information of marine migration dynamics, mortality and habitat use during their second year at sea. All of these studies will contribute to recommendations for additional measures to be considered to halt the decline of USA Atlantic salmon stocks and help restore these populations.

c) Cooperative Research

Network Projects

During 2012, the Northeast Cooperative Research Program (NCRP) supported a great deal of work through the conservation engineering and information technology networks established in 2010. These network groups bring together over 35 fishing industry, academic, non-profit, and government organizations to develop multi-disciplinary approaches to improve the industry's ability to avoid certain species so that healthier stocks can be fully harvested. This is being done by developing more selective fishing gear, focusing on patterns of fish distribution and environmental factors, and facilitating the real-time exchange of information to help fishermen target specific species while avoiding others. Additionally, some teams are exploring innovative survey methodologies to enhance stock assessments for selected species. Coordination of these network activities is being facilitated by NCRP staff members who provide technical and administrative support for network activities. Researchers, working with fisherman, net builders, and

industry advisors to provide ideas and expertise, are currently focusing their efforts on small and large mesh fisheries in Southern New England, the Gulf of Maine, and the Mid-Atlantic where bycatch is a major concern.

An extensive network group, the Northeast Groundfish Gear Conservation Engineering & Demonstration Network (GEARNET), is developing gear-based solutions to groundfish fishery bycatch. Principal investigators from the Gulf of Maine Research Institute (GMRI), Massachusetts Division of Marine Fisheries (MADMF), SMAST, Superior Trawl, and industry consult with fishermen in groundfish sectors and the common pool to determine their priority gear needs. During 2011 and 2012, the network supported 17 projects and in 2013, 12 new GEARNET projects will get underway to address a range of issues facing gillnetters and trawlers from Maine to Rhode Island. These projects target solutions in a few critical areas – maximizing allocations without exceeding cod or flatfish limits, avoiding harbor porpoise bycatch, reducing fuel costs, and reducing impacts on seabed habitat. Gear projects include topless flatfish trawls, raised-footrope gillnets and gillnet selectivity, the use of electric rod and reel to target haddock, using lighter twine, fuel meters, and re-engineered vessel stabilizers (a.k.a. 'birds') to improve fuel efficiency, and a flume tank workshop for trawl gear fishermen to gain an in-depth understanding of gear design and operation. GEARNET scientists are also teaming with Coastal Enterprises, Inc. to provide opportunities for fishermen to finance the purchase of semi-pelagic trawl doors, fuel flow meters, and acoustic trawl monitoring equipment that will increase vessels' fuel efficiency and decrease the impact of trawl gear on fishing habitat. More information on this network can be found at www.gearnet.org

Network groups focusing on bycatch reduction in the longfin squid fisheries include scientists from Cornell Cooperative Extension (CCE), University of Massachusetts-Dartmouth School of Marine Science & Technology (SMAST), and the University of Rhode Island. Potential gear solutions, such as large mesh belly panels and drop-chains, and sorting grids have been evaluated, and are proving effective at reducing bycatch of flounder, scup, and butterfish in near-shore areas. Additional efforts will encourage real time data collection and communication to avoid bycatch hotspots. The Squid Trawl Network (STN) website www.squidtrawlnetwork.com has been developed to inform stakeholders of network progress and direction.

Another team, involving the Garden State Seafood Association, Rutgers University, University of Delaware, University of New Hampshire, and CCE is developing ecologically-informed models to reduce butterfish bycatch in the squid fishery. Using fishermen's input the team is refining Integrated Ocean Observing System (IOOS) habitat models developed in conjunction with the Fisheries and the Environment (FATE) project to predict where the two species do not overlap for cleaner catches. For eight days in December, 2011, oceanographers from the University of Delaware and Rutgers transmitted daily model runs to a Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS) robot glider atop a commercial vessel at sea. Aboard the vessel, a scientific crew from the NEFSC then used this information to sample predicted "good" and "bad" butterfish habitat on the mid- and outer continental shelf to test the accuracy of the model. Initial modeling data predicted butterfish "hotspots" south of Martha's Vineyard, as well as east of Delaware and Chesapeake Bays, but signals on the vessel's hydroacoustic equipment and the captain's knowledge of the fishery continually lead the research team nearer the edge of the continental shelf and out of reach of the modeled habitat.

Therefore, while continuing to sample the model's predicted good and bad butterfish habitat, the team also had the captain pick a station in each area based on his practical ecological knowledge and fishing practices. From these targeted tows, it is evident that within broad-scale features, there are finer-scale gradients that fish and fishermen use as cues, and that these gradients are too fine to characterize from broad-scale instrumentation. With more precise, real-time information on the dynamic habitat defined by particular environmental features and processes such as deep-water thermal fronts, fishermen can learn to adapt fishing strategies to respond to these fine-scale, dynamic features to fish more selectively. To improve the development of habitat models for continental shelf species, they also need to be coupled with physical oceanographic models which will allow consideration of the properties and processes occurring below the surface of the ocean. This research team is also investigating the diet of longfin squid and their role as a predator to improve ecosystem-based management, and synthesizing the results of habitat

modeling, diet studies, and gear modifications to determine the population level impacts of different bycatch reduction strategies.

Both longfin squid research teams are now combining efforts to test a novel approach to survey methodologies. In order to improve estimates of catchability of butterfish in NEFSC trawl survey nets, the group is designing an experiment involving both traditional survey nets and acoustic sled equipment to determine the portion of a school of butterfish that may actually be captured in the survey net. This is critical information to improve stock assessments for butterfish, which can potentially be a limiting bycatch species in the squid fishery.

Two network groups are focusing on solutions to groundfish fishery bycatch that rely on real-time information about the distribution of species and bycatch events. One team, headed by the Cape Cod Commercial Hook Fishermen's Association (CCCHFA), Duke University, and Island Institute, has developed a temporal-spatial analysis of bycatch and catch damage to determine the correlation of these events in time and space. This information can be useful in establishing 'move-on' practices in which the fishermen would move a pre-determined distance from a bycatch event, or wait a suitable amount of time until the conditions for the event have changed. For example, the length of time it takes for a school of dogfish to move out of an area, or how far one must move to reduce the chances of encountering the school. Such strategic decisions can benefit fishermen by helping them maximize revenues by limiting bycatch and or damaged catch, and benefit the fishery resource by minimizing the bycatch of juveniles and non-target species, especially stocks of concern. This method may also be useful to minimize interactions with protected species, such as harbor porpoise and sturgeon. The results of this analysis are being reviewed for broader applicability in fixed gear fisheries and vetted through the CCCHFA for practical utility.

Another network segment led by GMRI, SMAST, Ocean Data Products and the University of Maine is developing a more generalized web-based data collection and communication system called the Fishing Area Selectivity Tool (FAST), to deliver near real-time information to fishermen to help avoid non-target species. The FAST tool is being developed to produce maps that combine historical observer information, oceanographic data layers such as temperatures and currents, and near real-time, self-reported fishery data at a scale that will be useful to fishermen. After discussions with industry groups, the pilot FAST project will focus on how this tool can be used to reduce gillnet interactions with harbor porpoise in the Gulf of Maine, and has been presented to the Harbor Porpoise Take Reduction Team for additional input and feedback. Future uses of the FAST tool could allow groups of fishermen to focus on any species of interest to reduce bycatch and/or to more efficiently harvest target species.

The REDNET network, including MADMF, Maine Department of Natural Resources, SMAST, Trawlworks, Superior Trawl, Reidar's Manufacturing Inc., and Associated Fisheries of Maine, aims to redevelop a sustainable redfish (Sebastes fasciatus) fishery in the Gulf of Maine. Initial work demonstrated that a clean redfish fishery can be prosecuted in certain areas in the Gulf of Maine. Current work is focusing on size selectivity using 4.5", 5.5" and 6.5' mesh codends. Additional work could include the use of bycatch reduction devices if deemed necessary.

Survey Sweep Study Research

Analysis for the paired trawl portion of a two-year cooperative trawl sweep comparison study was completed that evaluated the relative catch efficiency of cookie and rockhopper sweeps on skates and flatfish (including winter, summer and yellowtail flounder). A total of 374 paired tows from three distinct sampling periods (53 pairs from fall 2009, 211 from spring of 2010, and 110 from fall 2010) were used in the analysis. There were sufficient observations for analysis for two skate species (winter skate and little skate), seven flatfish species (yellowtail flounder, summer flounder, winter flounder, witch flounder, fourspot flounder, windowpane, and American plaice) and monkfish. Relative catch efficiencies by sweep type and standard errors were estimated for each species. In all of the species analyzed, catch efficiency was estimated to be higher for the cookie sweep with catch per unit effort ratios (cookie/rockhopper) ranging from 1.18 (goosefish) to 2.83 (little skate). These estimates will allow future direct comparison between data collected with the two sweep types for the analyzed species.

Dogfish Tagging

In 2012, a cooperative spiny dogfish (*Squalus acanthias*) tagging study in the Gulf of Maine, Southern New England, and Georges Bank regions on three commercial vessels was completed. This project was undertaken to provide information on stock structure, movement patterns, and life history of the species to update and improve the stock assessment. Over two years, 34,604 spiny dogfish were tagged and 488 of these sharks have been recaptured to date. For more detailed information on this study and data from the recaptures, please see the Apex Predators Program section of this report.

Study Fleet

Cooperative Research continues to support the Electronic Logbook/Study Fleet Program, which focuses on using electronic reporting mechanisms for recording haul-based data (including temperature and depth profiles), and providing direct assistance to industry partners. In 2012, the program included 30 vessels operating in the groundfish, squid, scallop, and Southern New England yellowtail fisheries. Currently, the Study Fleet electronic logbook is the only fishery-dependent reporting system providing near real time tow-by-tow data to the NEFSC (often within 48 hours of a vessel completing a trip). Data collected from the logbooks will be used to investigate precision in discard estimates, as well as to identify patterns in fishery dependent catch per unit effort.

Study Fleet-based projects include developing methods to characterize and record modifications to otter trawls to reflect the catch and discard associated with selected gear parameters, collecting data on river herring bycatch in the small mesh bottom trawl fishery, enhanced flatfish biological sampling for age, growth and fecundity, and efforts to review and update the current dressed-weight conversion factors for Atlantic cod, haddock, pollock, goosefish and winter skate. Study Fleet participants are also helping to test a new, affordable wireless temperature-depth probe developed with NCRP funding to identify environmental conditions associated with catch and bycatch in near-real time. Bottom temperature information from Study Fleet participants is also being used by collaborating habitat and oceanographic modelers to test and improve their models and to develop new models which forecast not only wave heights and current directions, but also ocean bottom temperatures. This information will help fishermen make more strategic decisions about fishing selectively. A more complete discussion about bottom temperature mapping follows below. Cooperative Research is seeking additional opportunities to expand the use of the Study Fleet Electronic Logbook system, known as FLDRS (Fisheries Logbook and Data Recording Software), in other cooperative studies and sectors to enhance fishery dependent data.

eMOLT

The Environmental Monitors on Lobster Traps, or eMOLT program continued throughout 2012. This partnership, involving NOAA, the State of Maine, the Commonwealth of Massachusetts, various lobstermen's associations, the Gulf of Maine Lobster Foundation, and the Marine Science Department at Southern Maine Community College (SMCC) in South Portland, Maine, facilitates environmental monitoring using a combination of temperature and current meter probes on lobster pots, as well as a series of GPS drifter deployments. The project continues to collect hourly bottom temperatures from nearly 70 fixed locations around the Gulf of Maine and the Southern New England Shelf, and is also providing this bottom temperature information for ocean modeling work detailed below. The eMOLT mission is primarily motivated by lobster science and the need to document environmental conditions, but the vast eMOLT database is also accessible to the general public. For more information and data access, see www.emolt.org.

Bottom Temperature Mapping

Ocean bottom temperatures can vary greatly from the sea surface temperatures, and even a few degrees' difference can affect the behavior of marine species. Thus, when known, bottom temperature can be an extremely useful tool for fishermen trying to selectively and efficiently target certain species. Because water temperatures can have such strong effects on patterns of distribution, this information is also critical for scientific assessments of fish stocks and marine ecosystems, particularly when ocean climates are

changing rapidly. Cooperative Research projects such as the Squid Trawl Network and Study Fleet program are recording bottom temperature during commercial fishing activities in the Northeast and mid-Atlantic, and combining this information with fish capture data collected during surveys and study fleet trips to improve distribution maps of key commercial species.

In 2011 and 2012, to give fishermen a more affordable tool to access real-time bottom temperature information, the NCRP funded the development of a Wireless Temperature-Depth (TD) probe through the Aquatec Group, LTD. This new probe transmits temperature and depth information wirelessly from the fishing gear as it is hauled to the surface to a computer located onboard, without requiring the probe to be removed from the gear. This advance in technology enables fisherman to view data on a monitor in the wheelhouse, and make correlations between the temperature data they are seeing and the marine species they are catching. Ten of the Wireless TD units are currently being tested by eMOLT and Study Fleet participants, and the feedback has been extremely positive. During the testing, temperature and depth data collected by the eMOLT project has discovered additional information regarding lobster gear being lifted off of the bottom in certain current situations. Additionally, some Study Fleet captains are using bottom-temperature data to help predict where they may encounter certain species they wish to avoid, such as dogfish.

Both eMOLT and the NCRP are sharing this important data with IOOS, NERACOOS, and MARACOOS. Over several years, the Study Fleet has collected over 2 million bottom temperature and location records during more than 30,000 commercial fishing tows, and since 2001, the eMOLT program has recorded more than 5 million hourly records of bottom temperature. This additional information will help oceanographic modelers better assess and improve models developed through earlier technology, and to develop new models which forecast not only wave heights and current directions, but also ocean bottom temperatures. Integrating catch data with fishing gear's depth and temperature information will also facilitate and verify ecosystem modeling approaches which are greatly needed to better understand ocean dynamics and how they affect marine species.

Research Set-Asides

The Research Set-Aside (RSA) programs held 2012 grant competitions for Sea Scallops, Monkfish, and Mid-Atlantic multispecies. Scallop RSA awards included support for resource assessments of rotational management areas, the development of a hydrodynamic scallop dredge to reduce impact on the seabed and increase fuel efficiency, continuation of a real time electronic bycatch reporting study, and bycatch/mortality reduction studies to reduce the impact of scallop fishing on flatfish, skates, and sea turtles.

Mid-Atlantic RSA awards included the Northeast Area Monitoring and Assessment Program (NEAMAP), and a fishery independent survey of scup and black sea bass on hard bottom areas in Southern New England and untrawlable areas in the Mid-Atlantic. NEAMAP is a network of near shore trawl surveys designed to contribute important information to the management of Atlantic Coastal fish stocks. The network is made up of several survey efforts, including the NEAMAP Mid-Atlantic/Southern New England (MA/SNE) Near Shore Trawl Survey, the Massachusetts State Trawl Survey, and the Maine-New Hampshire Inshore Trawl Survey. Now in its sixth year, the NEAMAP MA/SNE survey has made valuable contributions to near shore marine fisheries assessments, research and monitoring.

Collaborators from the University of Rhode Island, UMass-Dartmouth School for Marine Science and Technology, the Rhode Island Department of Environmental Management Division of Fish and Wildlife, Massachusetts Division of Marine Fisheries, New Jersey Department of Environmental Management Fish and Wildlife, the Virginia Marine Resources Commission and NOAA Fisheries Service are working with stakeholders to develop an expanded pot survey for black sea bass to fill in gaps in seasonal trawl surveys. Using unvented fish pots, the survey targets black sea bass from hard bottom sites typically not sampled by the current trawl-based NEAMAP survey, or ongoing state and federal bottom trawl surveys. Four separate hard bottom sites are being sampled from June through October in southern New England, and from April through August in the Mid-Atlantic. Information from this survey can be used to track year classes of fish over their range, and detect sub-regional differences in abundance, as well as provide enhanced information

on abundance, age and growth, and life history. These results are expected to improve stock assessments and help inform localized management for this data poor species.

2011 and 2012 awards under the Monkfish RSA supported projects on movement, age verification and stock structure for monkfish. The University of Maryland-Eastern Shore is studying the effects of climate change on the abundance, movement and growth of monkfish. Cornell University's Cooperative Extension of Suffolk County is examining the coastal stock structure of monkfish using microsatellite DNA analysis to differentiate between northern and southern stocks, and the University of Massachusetts-School of Marine Science and Technology is continuing to study their age and growth parameters.

d) Stock Assessment Methods Development

Many national and international studies have concluded that stock assessments should evaluate resource status using a number of different analytical approaches. By doing so, some indication of the robustness of conclusions regarding stock status is achieved. To this end, NEFSC researchers have been collaborating with other NOAA fisheries scientists to develop a standardized suite of methods collected into a software toolbox. The NOAA Fisheries Toolbox (NFT) incorporates a wide range of methods (such as virtual population analysis, reference point estimation, surplus production and forward-projection methods) into a stable environment with tested software products. The NFT is used for many routine assessment tasks. No new methods were added to the toolbox in 2012, but several programs (ASAP, SS3, AGEPRO and POPSIM) were updated. The complete package may be accessed at http://nft.nefsc.noaa.gov/ (note that a password is no longer required).

e) Sea scallop research

The NEFSC began deploying a towed camera system called Habcam v4, during its annual sea scallop/integrated benthic survey in 2012. This system consists of two digital still cameras for stereo optics synched to four high-speed strobes as well as a side-scan sonar unit and numerous oceanographic instruments. The unit is towed at 5-7 knots and is maintained about 2 m above the sea floor. Over four million image pairs of the sea floor were collected during the 2012 survey. These have been used to estimate sea scallop abundance, and potentially can be used to obtain estimates of common demersal finfish such as flounders, skates and hakes. Habcam data will also be useful for benthic community and habitat characterization, and for evaluation of habitat impacts of fishing gear.

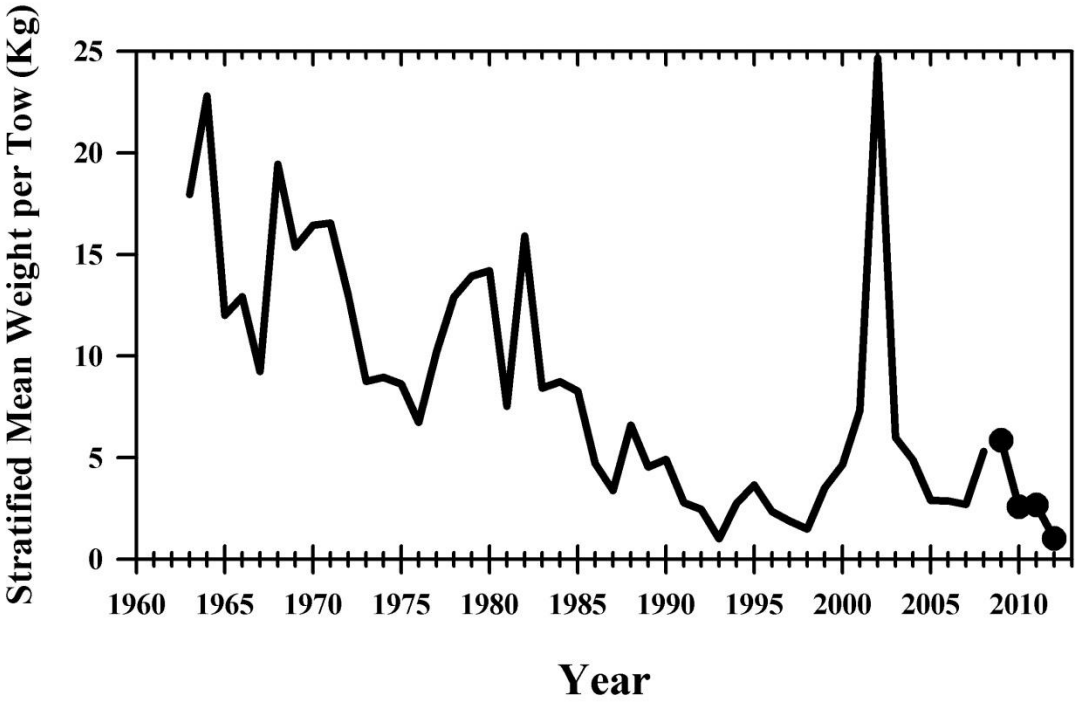

Figure 1. NEFSC autumn bottom trawl survey biomass indices for Gulf of Maine cod.

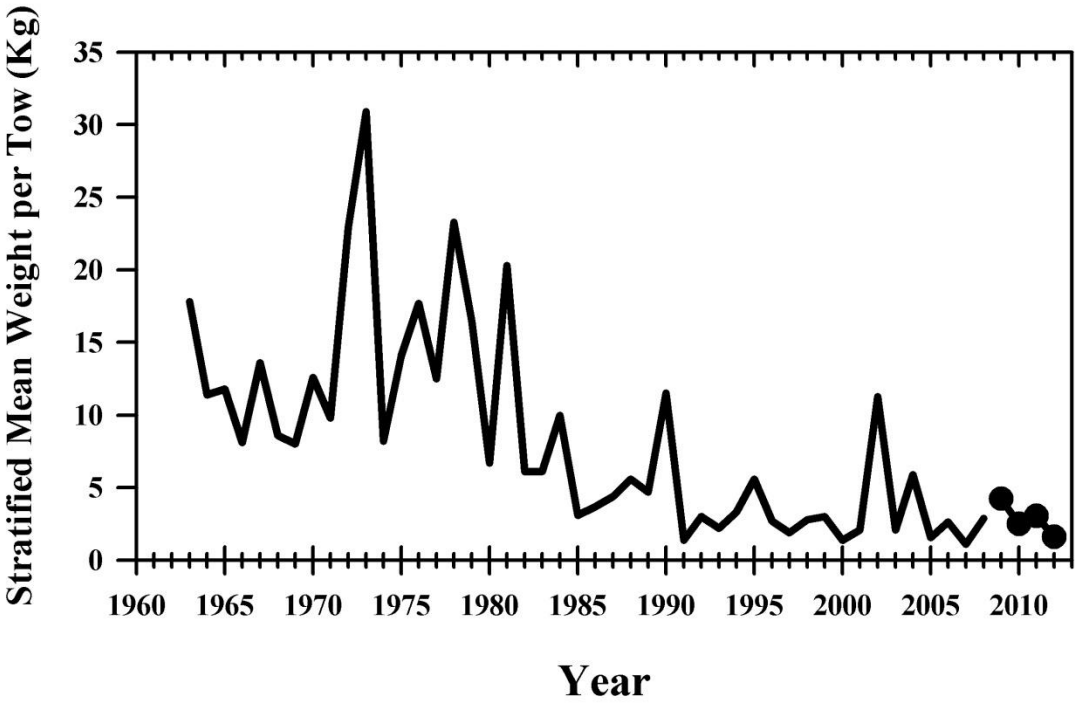

Figure 2. NEFSC autumn bottom trawl survey biomass indices for Georges Bank cod.

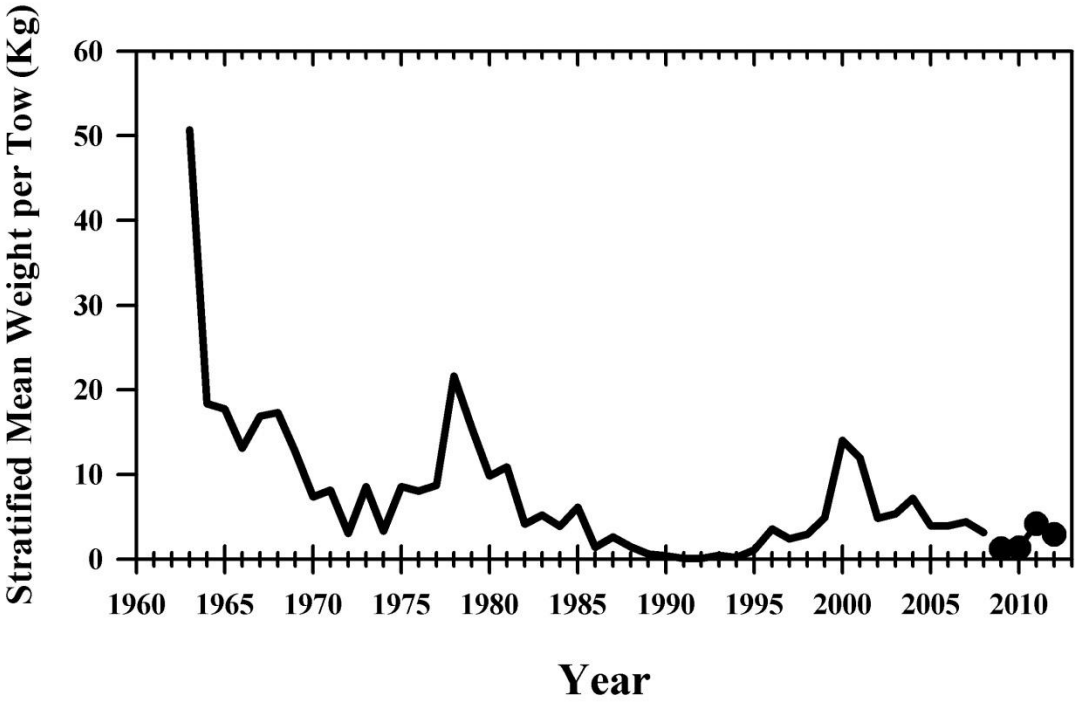

Figure 3. NEFSC autumn bottom trawl survey biomass indices for Gulf of Maine haddock.

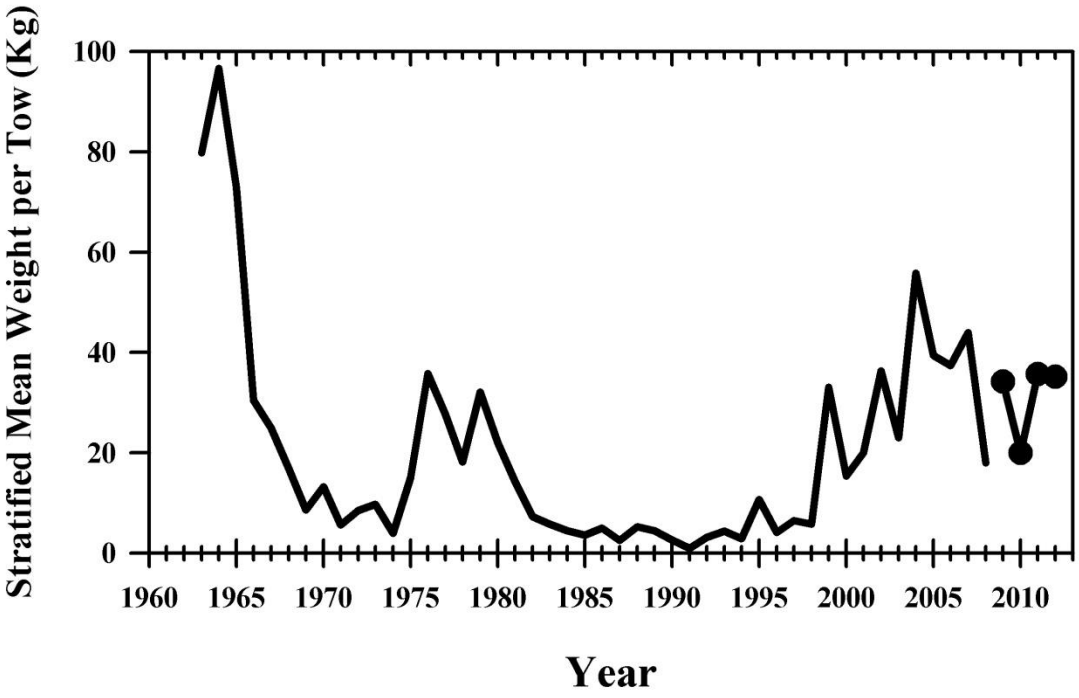

Figure 4. NEFSC autumn bottom trawl survey biomass indices for Georges Bank haddock.

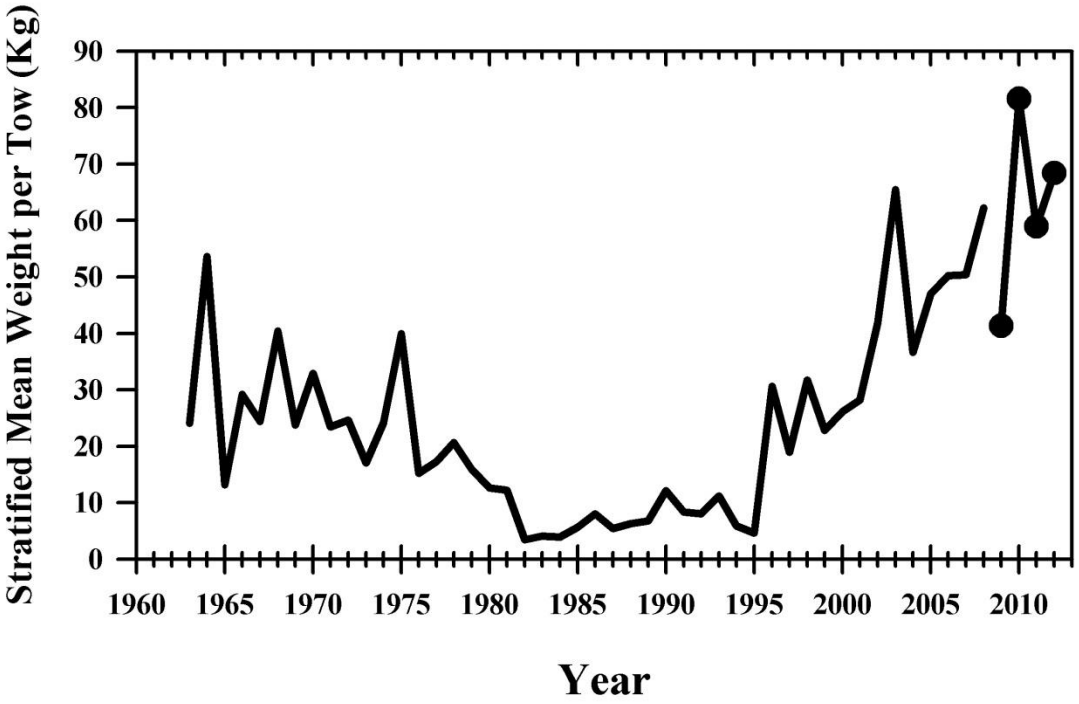

Figure 5. NEFSC autumn bottom trawl survey biomass indices for Acadian redfish.

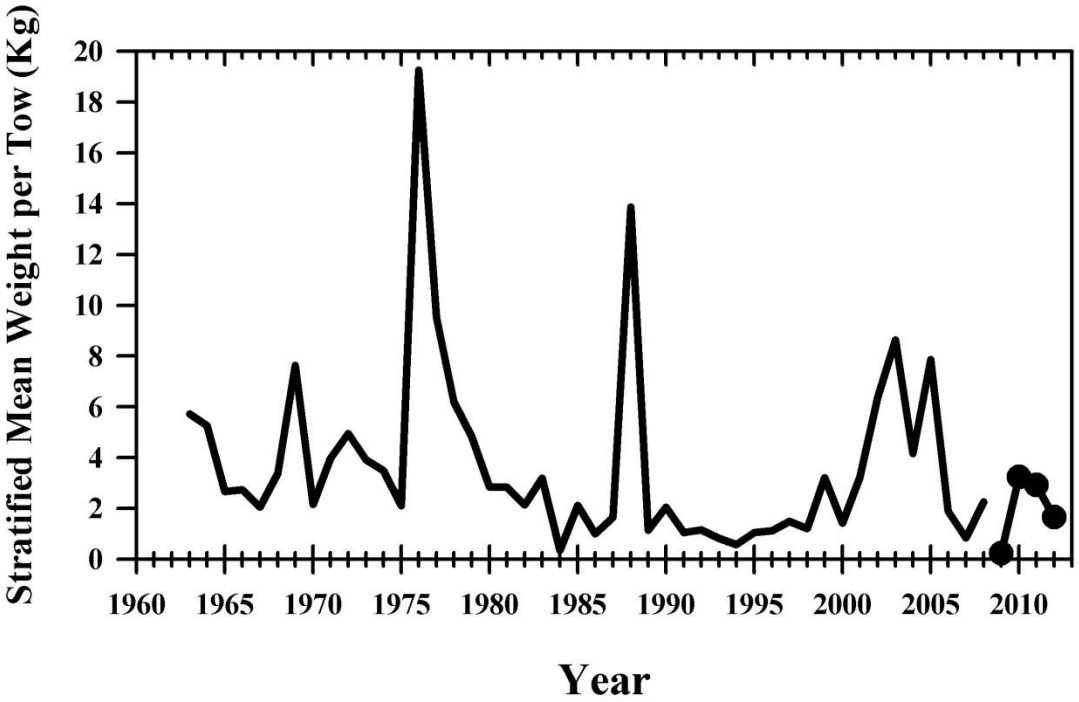

Figure 6. NEFSC autumn bottom trawl survey biomass indices for pollock.

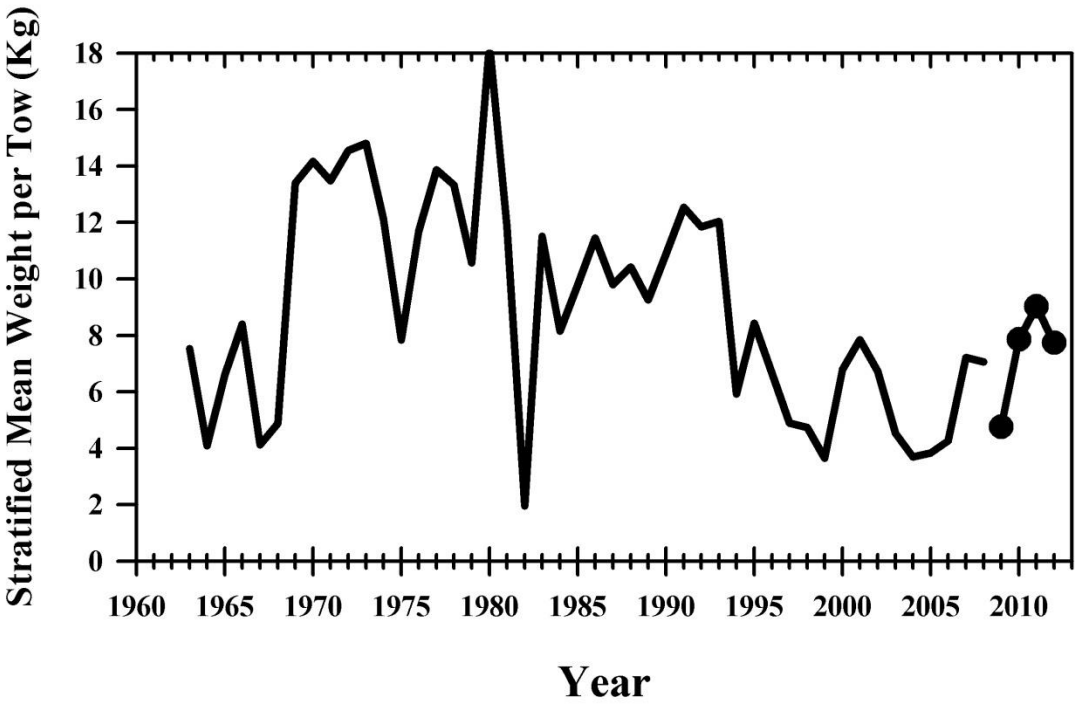

Figure 7. NEFSC autumn bottom trawl survey biomass indices for white hake.

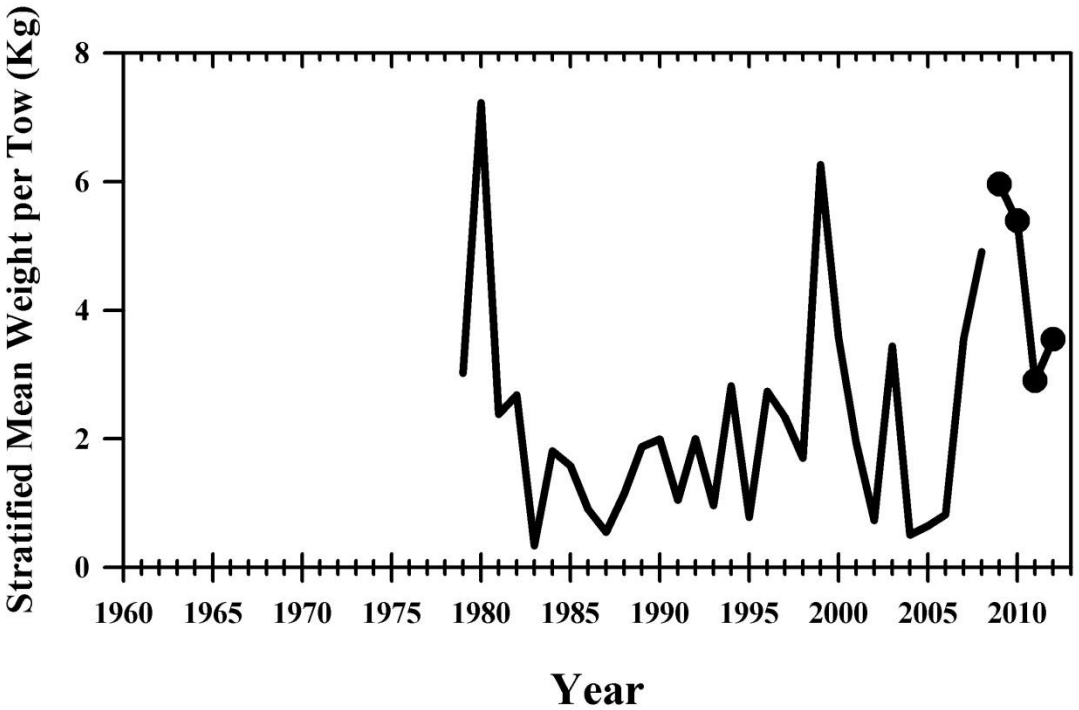

Figure 8. NEFSC autumn bottom trawl survey biomass indices for Cape Cod-Gulf of Maine yellowtail flounder.

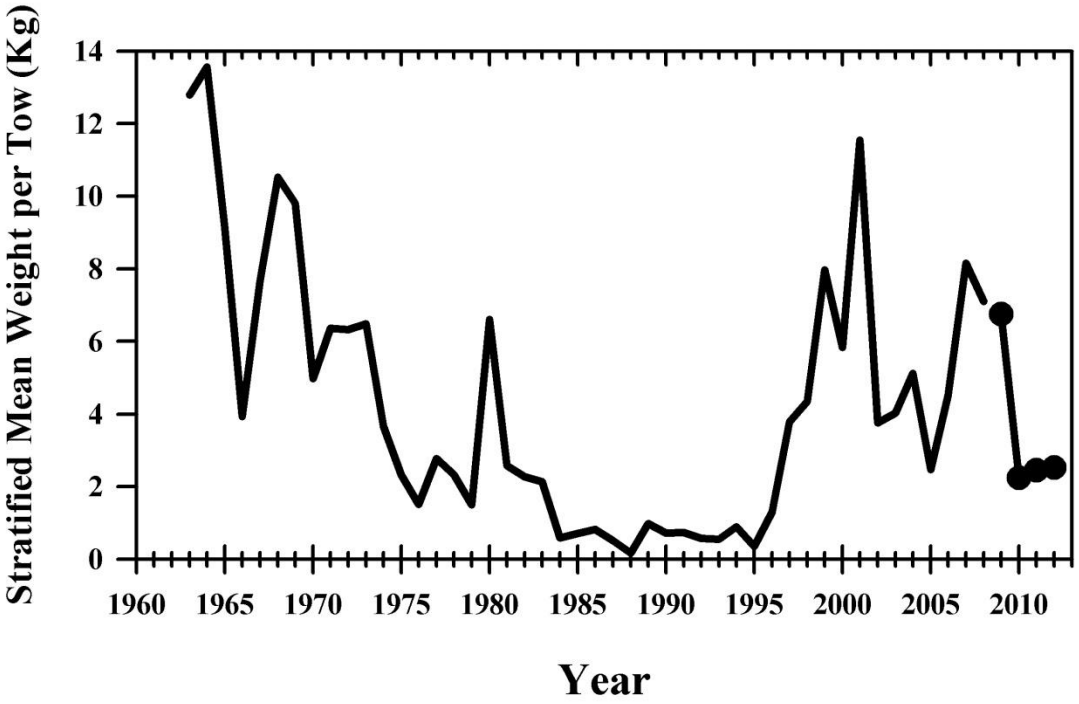

Figure 9. NEFSC autumn bottom trawl survey biomass indices for Georges Bank yellowtail flounder.

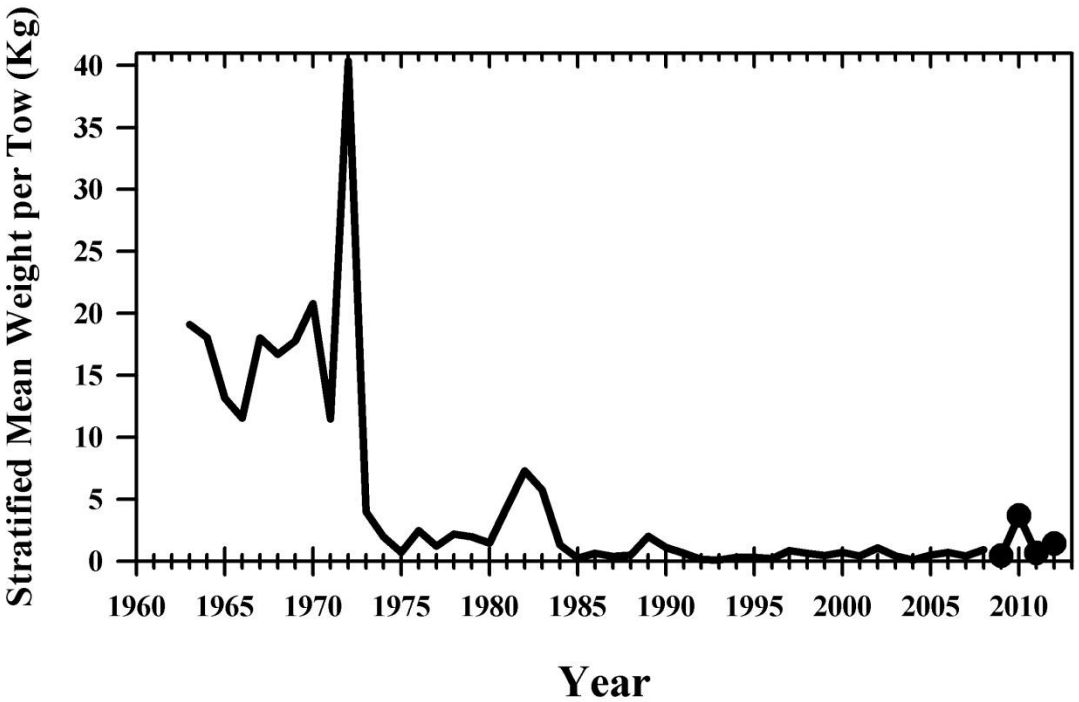

Figure 10. NEFSC autumn bottom trawl survey biomass indices for Southern New England-Mid-Atlantic yellowtail flounder.

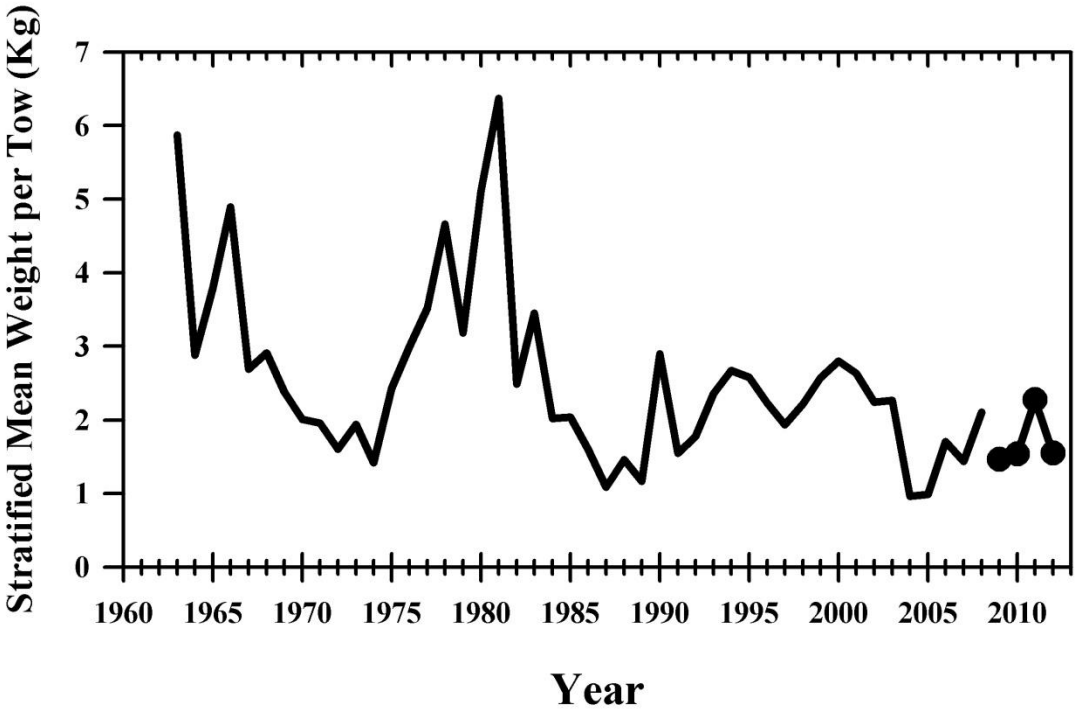

Figure 11. NEFSC autumn bottom trawl survey biomass indices for American plaice.

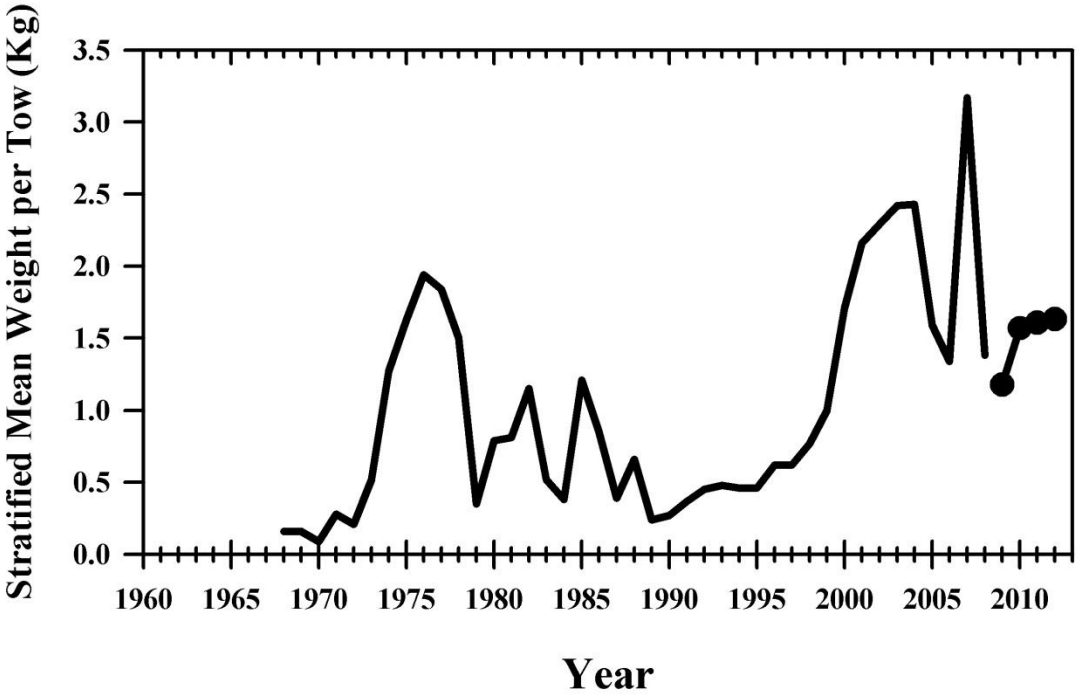

Figure 12. NEFSC spring bottom trawl survey biomass indices for summer flounder.

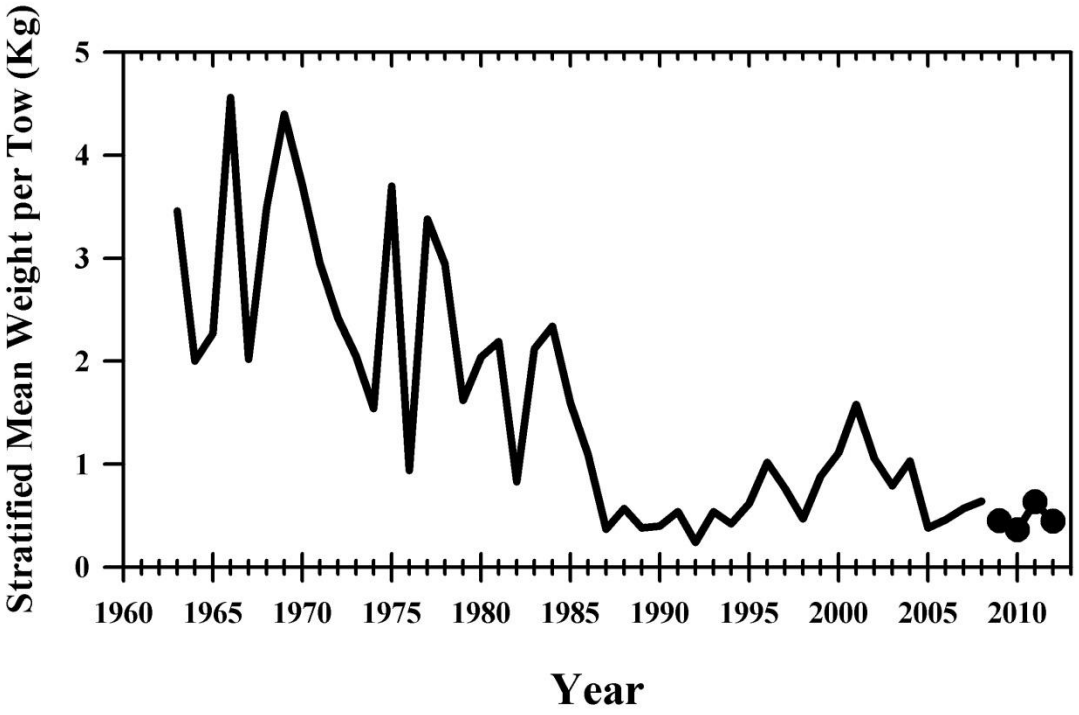

Figure 13. NEFSC autumn bottom trawl survey biomass indices for witch flounder.

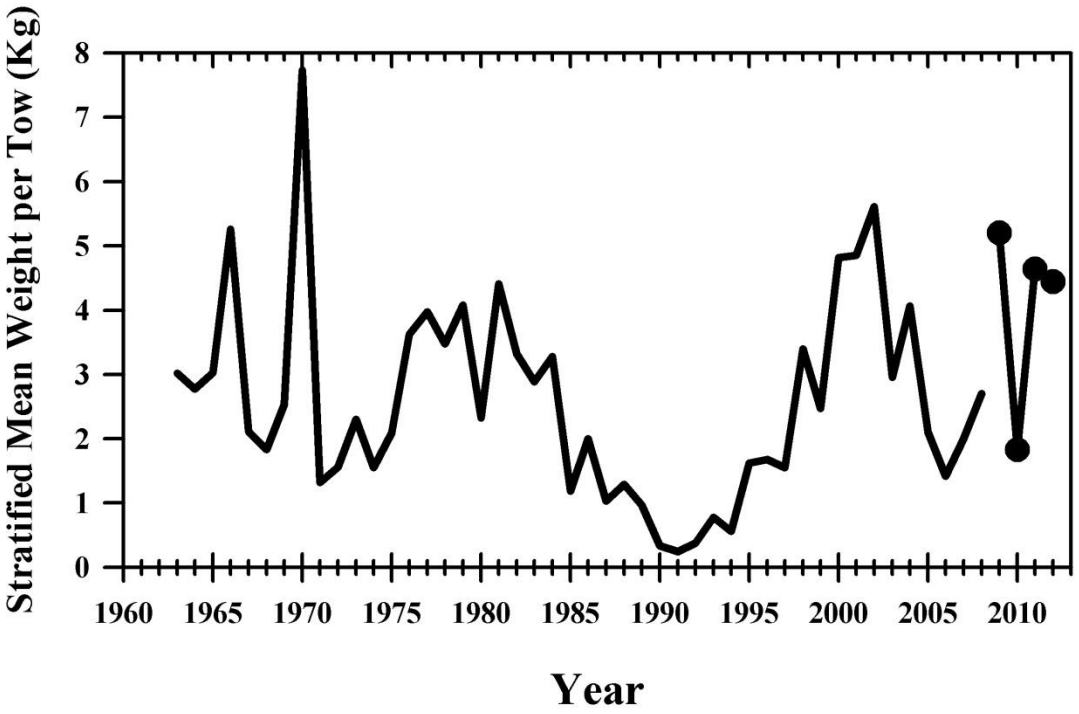

Figure 14. NEFSC autumn bottom trawl survey biomass indices for Georges Bank winter flounder.

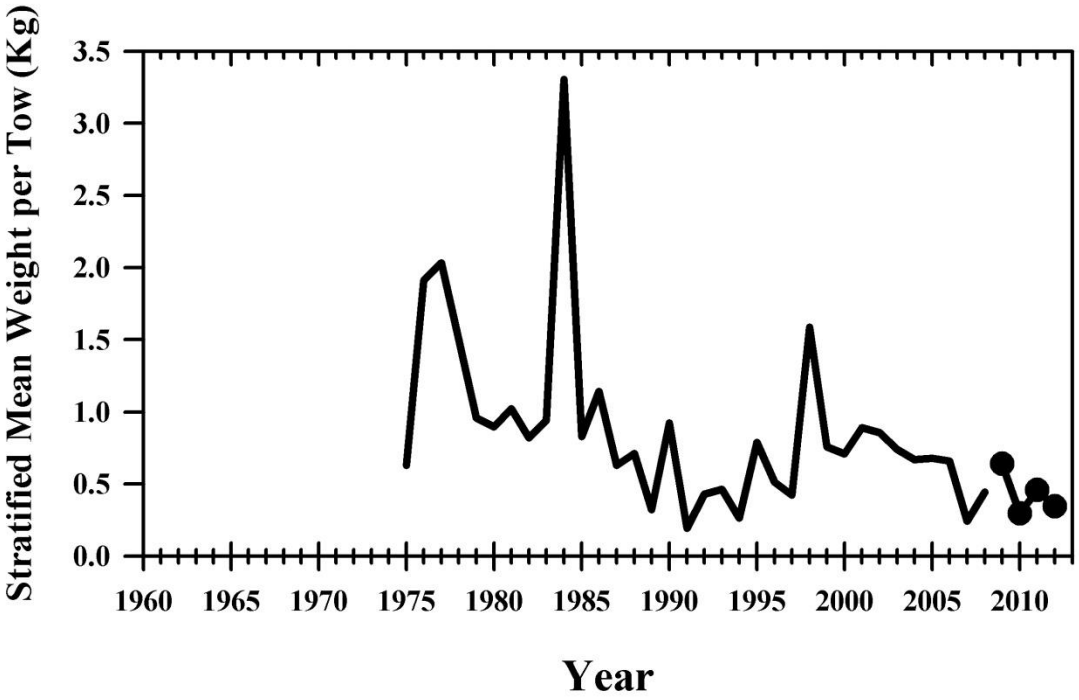

Figure 15. NEFSC autumn bottom trawl survey biomass indices for northern windowpane flounder.

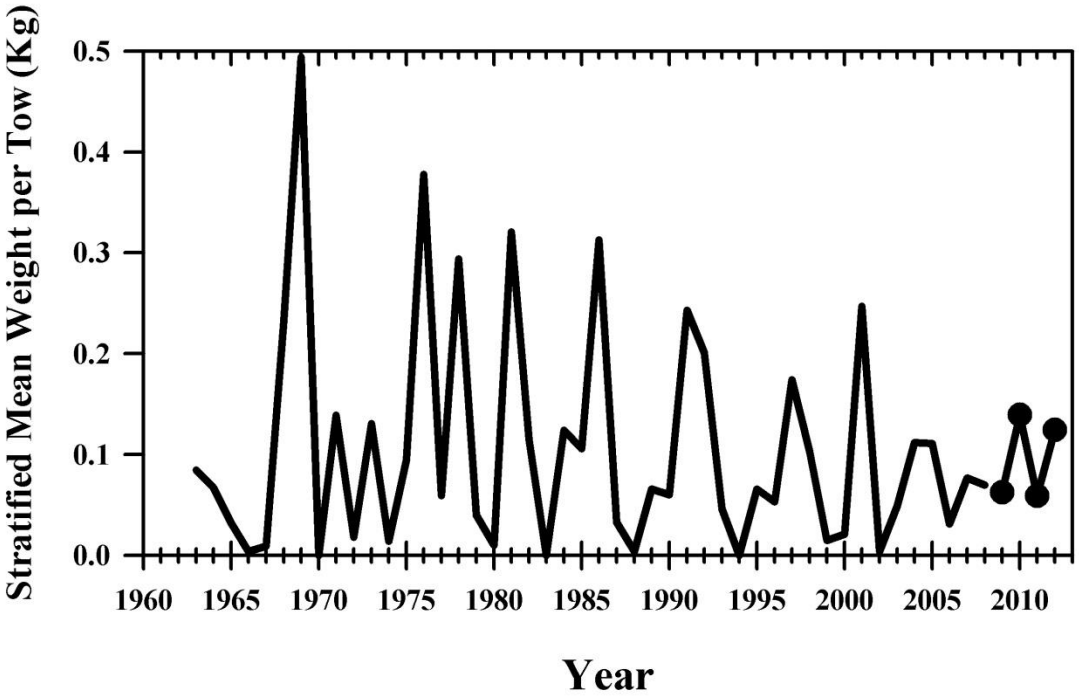

Figure 16. NEFSC autumn bottom trawl survey biomass indices for Atlantic halibut.

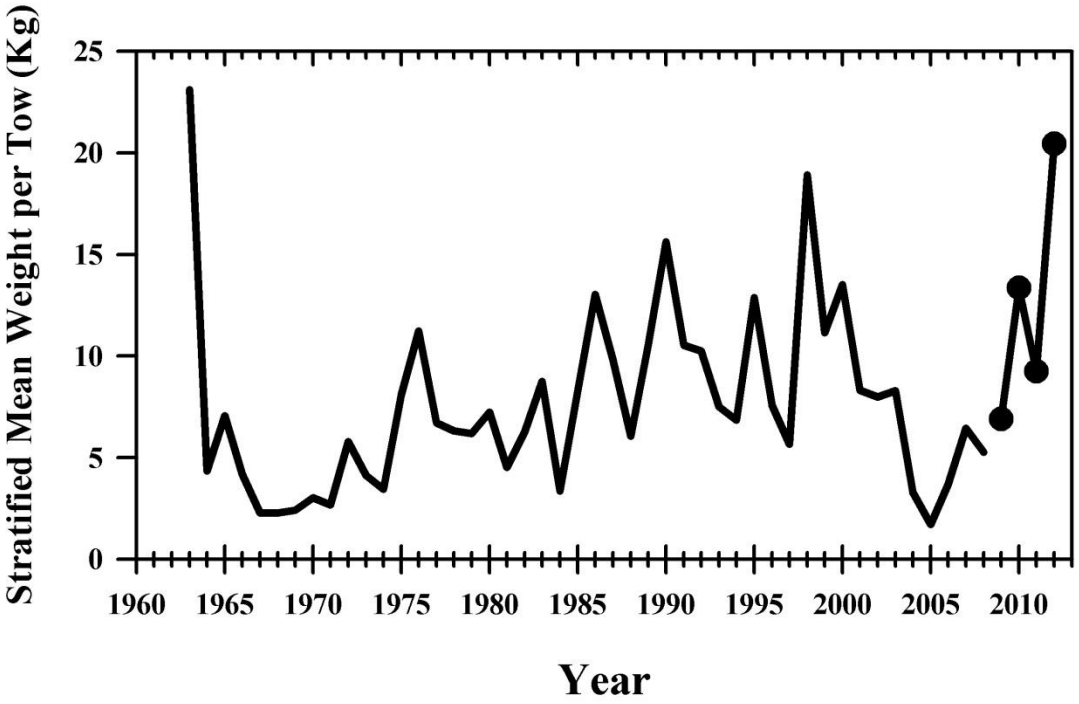

Figure 17. NEFSC autumn bottom trawl survey biomass indices for northern silver hake.

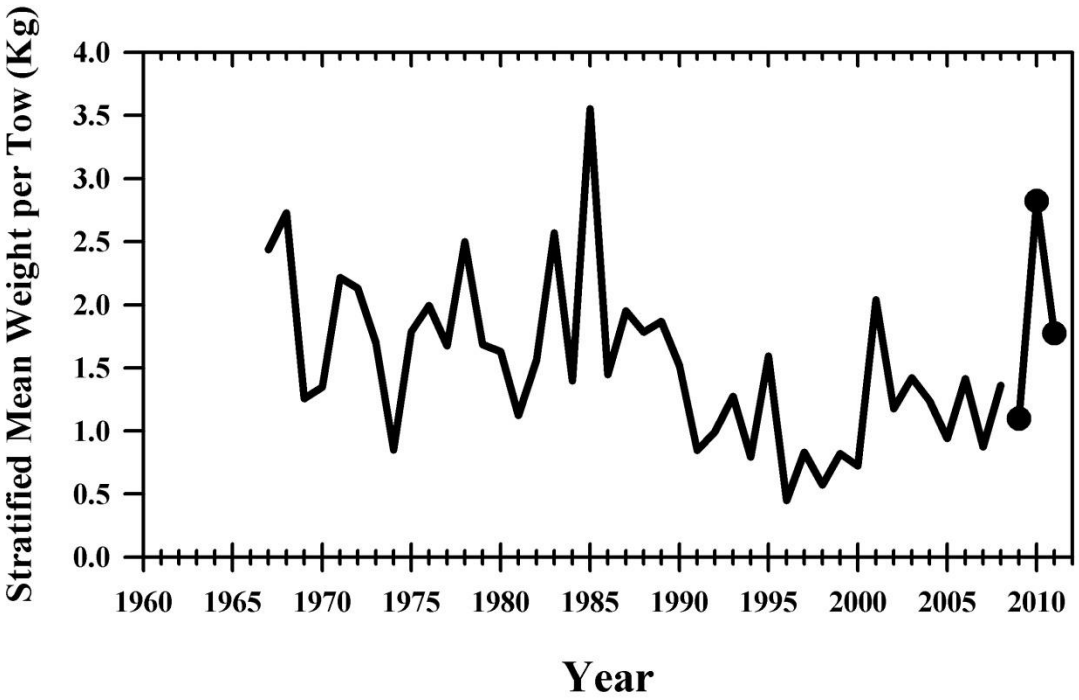

Figure 18. NEFSC autumn bottom trawl survey biomass indices for southern silver hake.

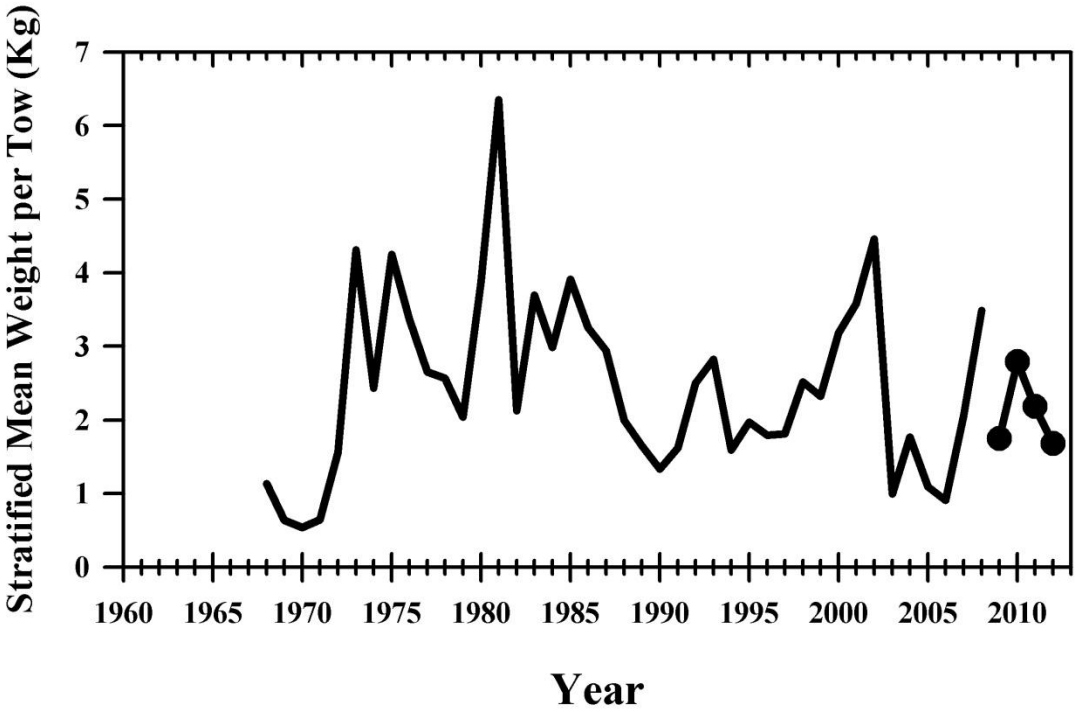

Figure 19. NEFSC spring bottom trawl survey biomass indices for northern red hake.

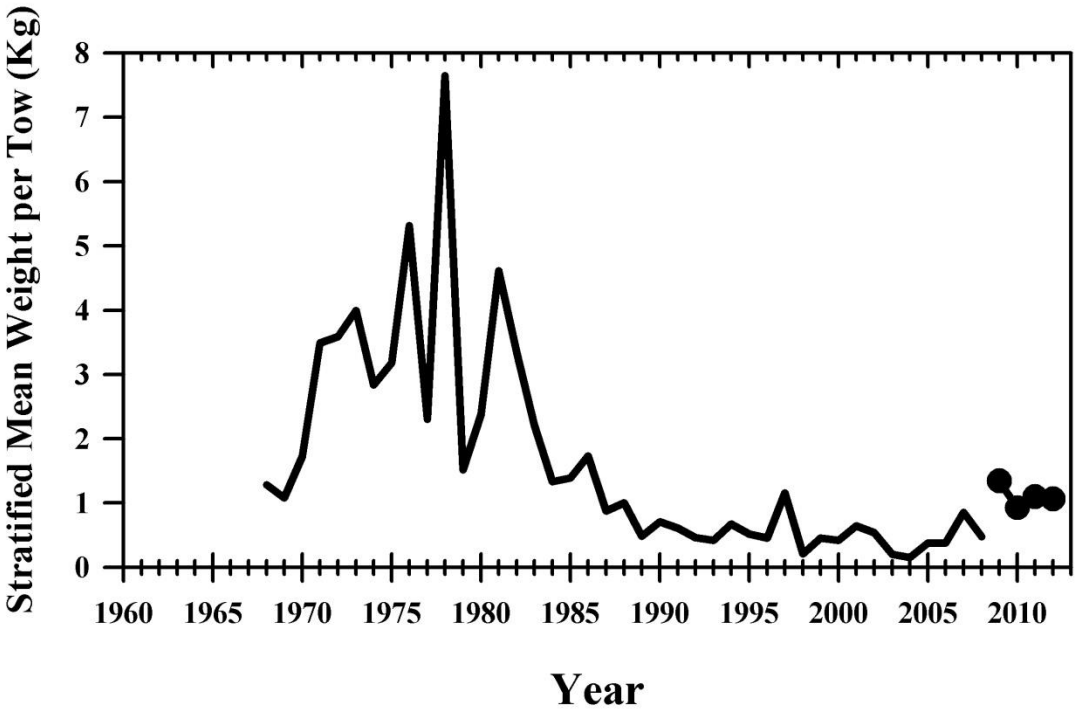

Figure 20. NEFSC spring bottom trawl survey biomass indices for southern red hake.

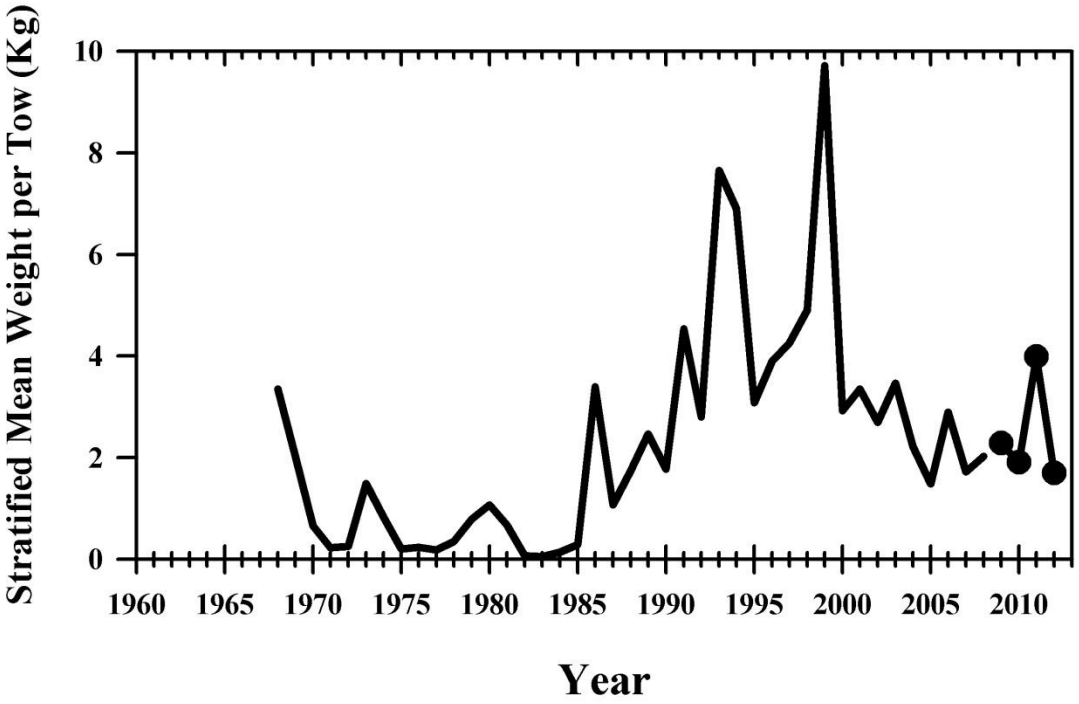

Figure 21. NEFSC spring bottom trawl survey biomass indices for Atlantic herring.

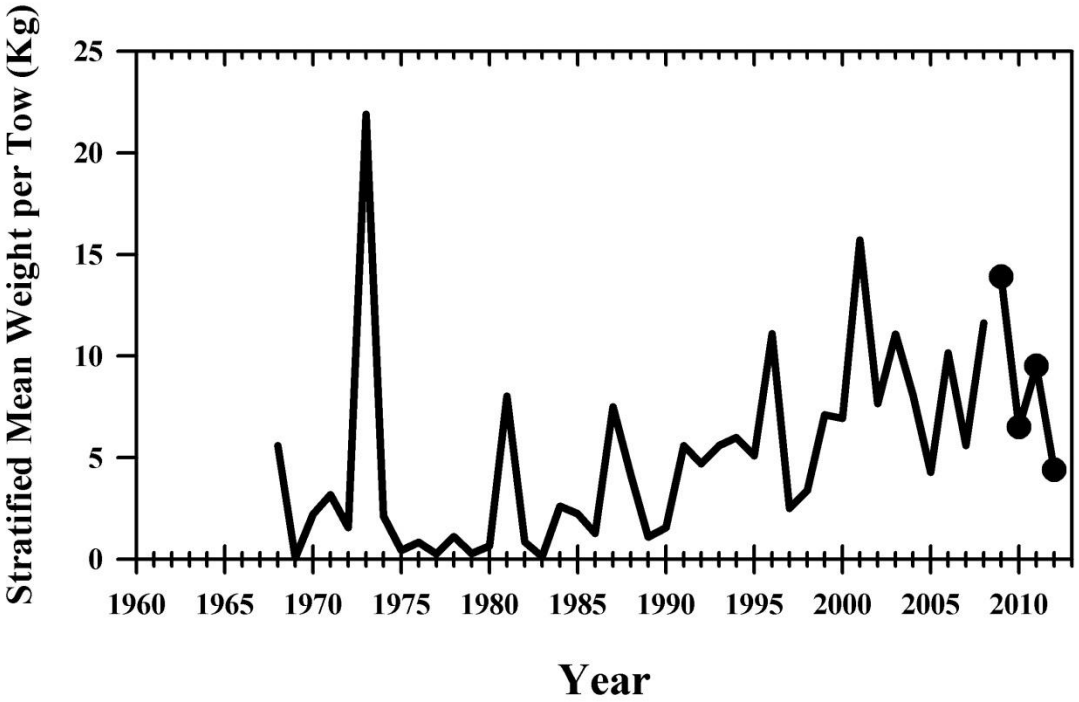

Figure 22. NEFSC spring bottom trawl survey biomass indices for Atlantic mackerel.

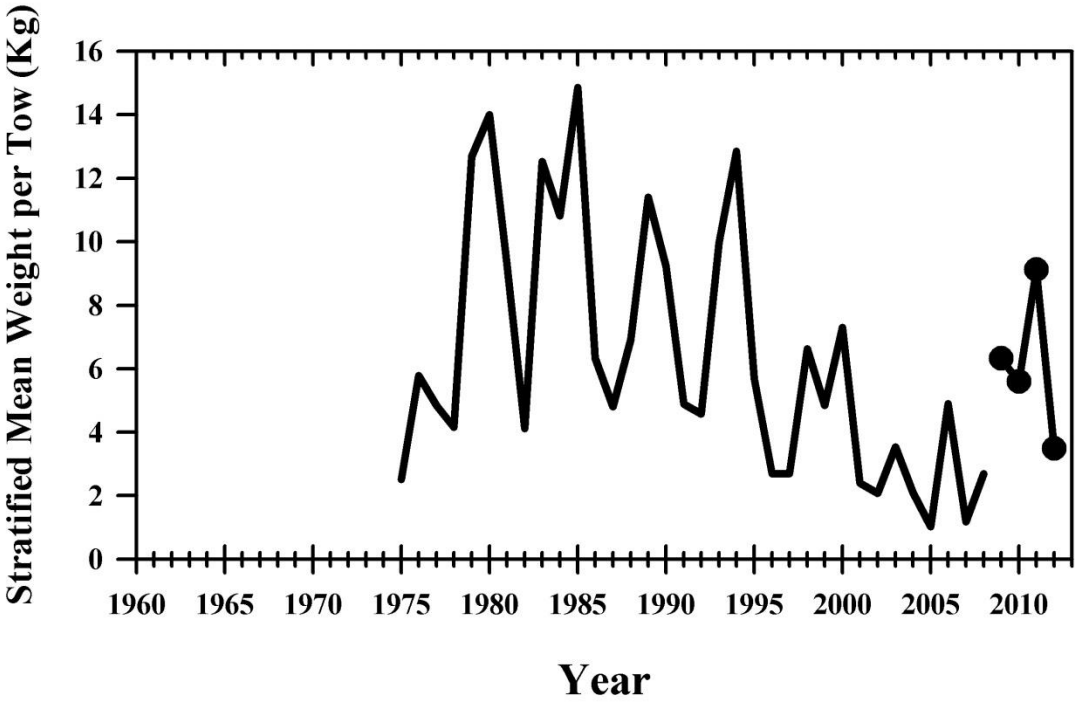

Figure 23. NEFSC autumn bottom trawl survey biomass indices for butterfish.

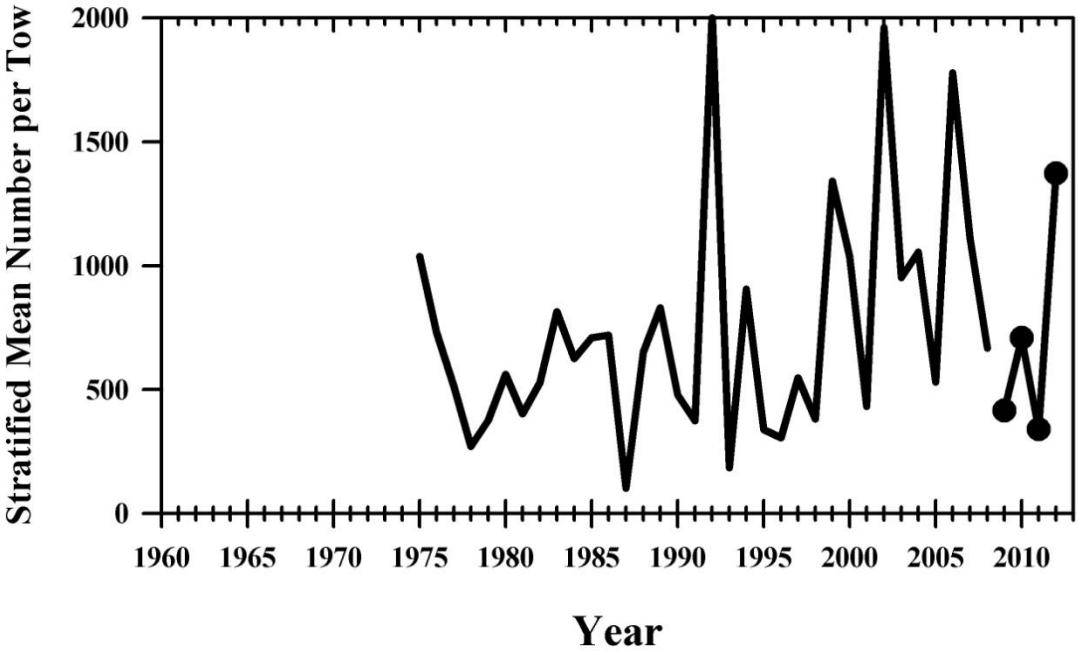

Figure 24. NEFSC autumn bottom trawl survey abundance indices for longfin inshore squid.

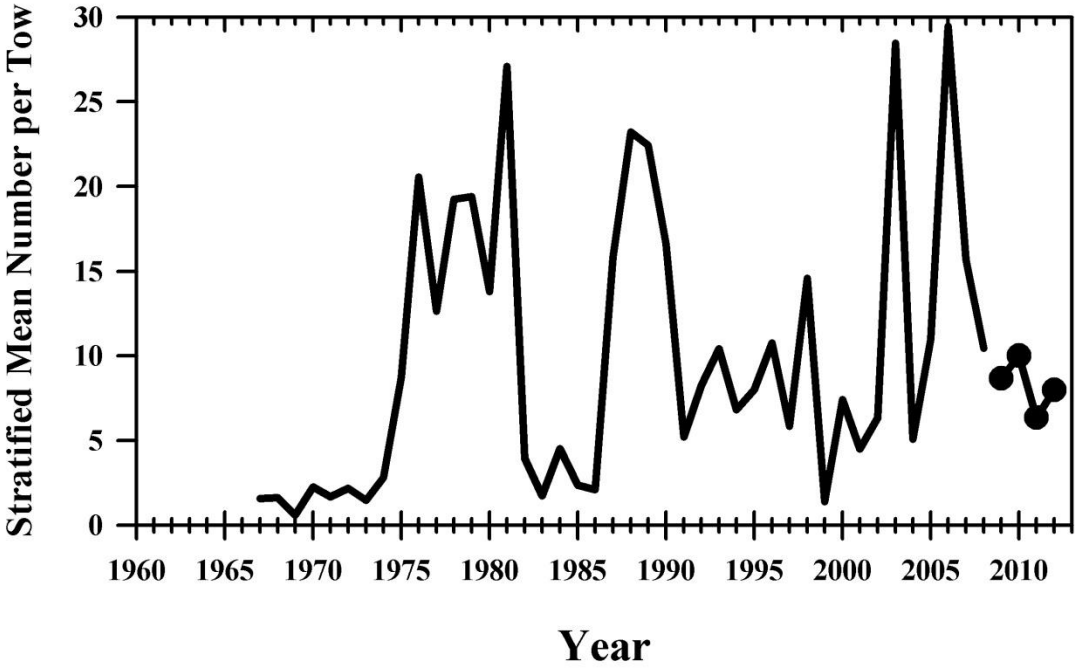

Figure 25. NEFSC autumn bottom trawl survey abundance indices for northern shortfin squid.

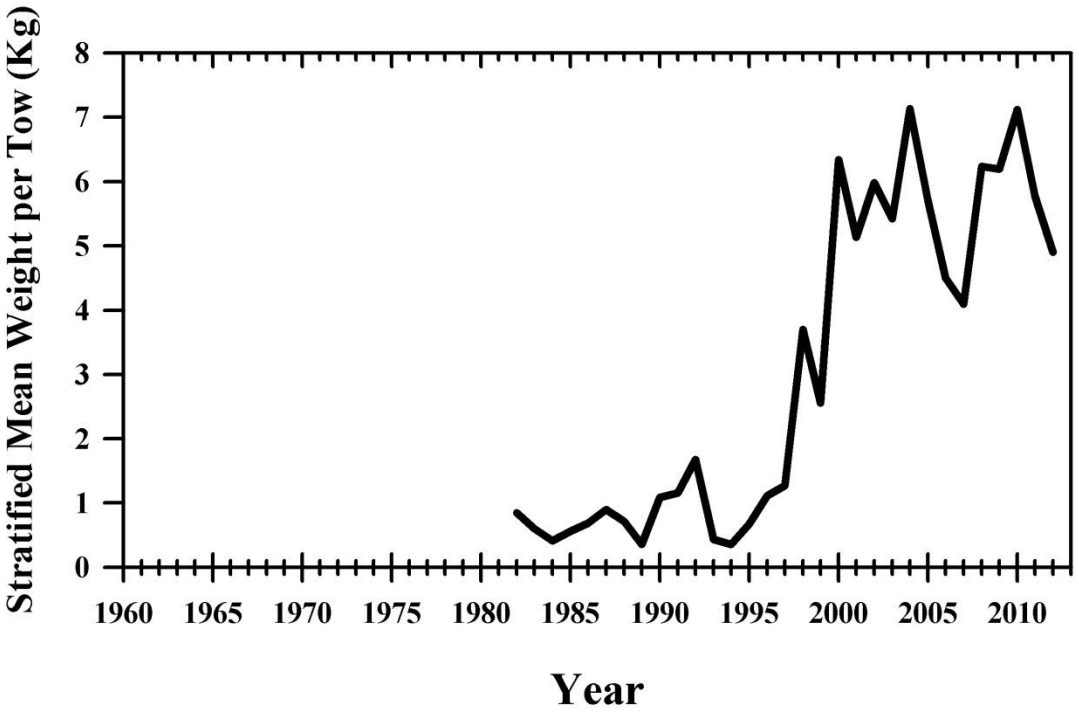

Figure 26. NEFSC scallop survey biomass indices for Georges Bank sea scallops.

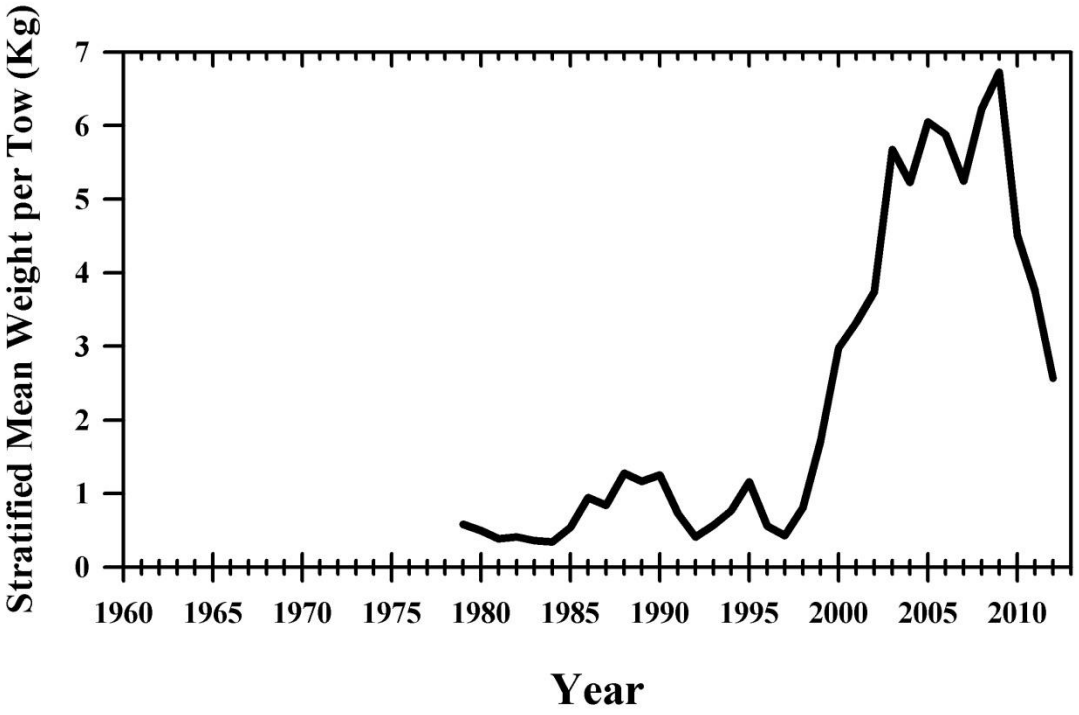

Figure 27. NEFSC scallop survey biomass indices for Mid-Atlantic Bight sea scallops.

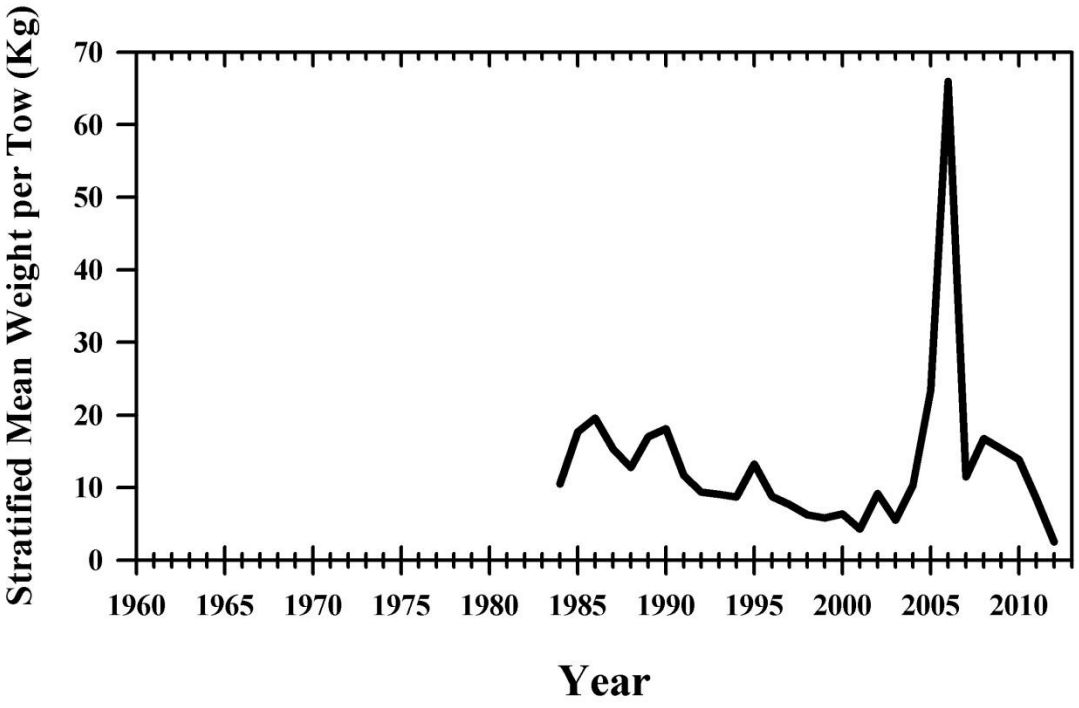

Figure 28. ASMFC summer shrimp survey biomass indices for northern shrimp.

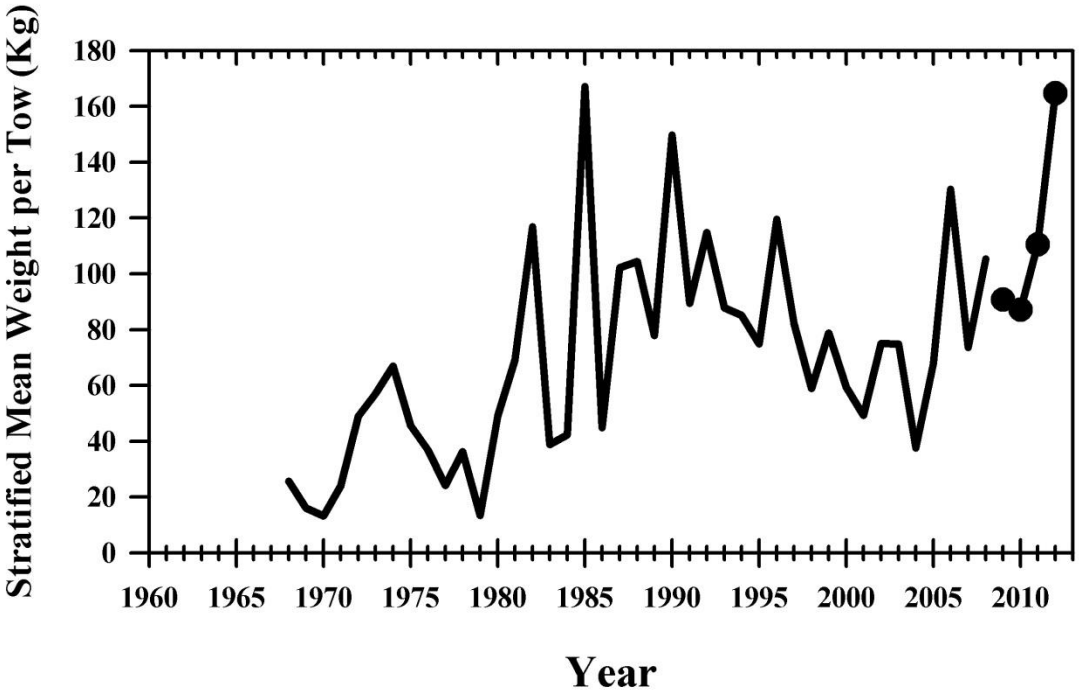

Figure 29. NEFSC spring bottom trawl survey biomass indices for spiny dogfish.

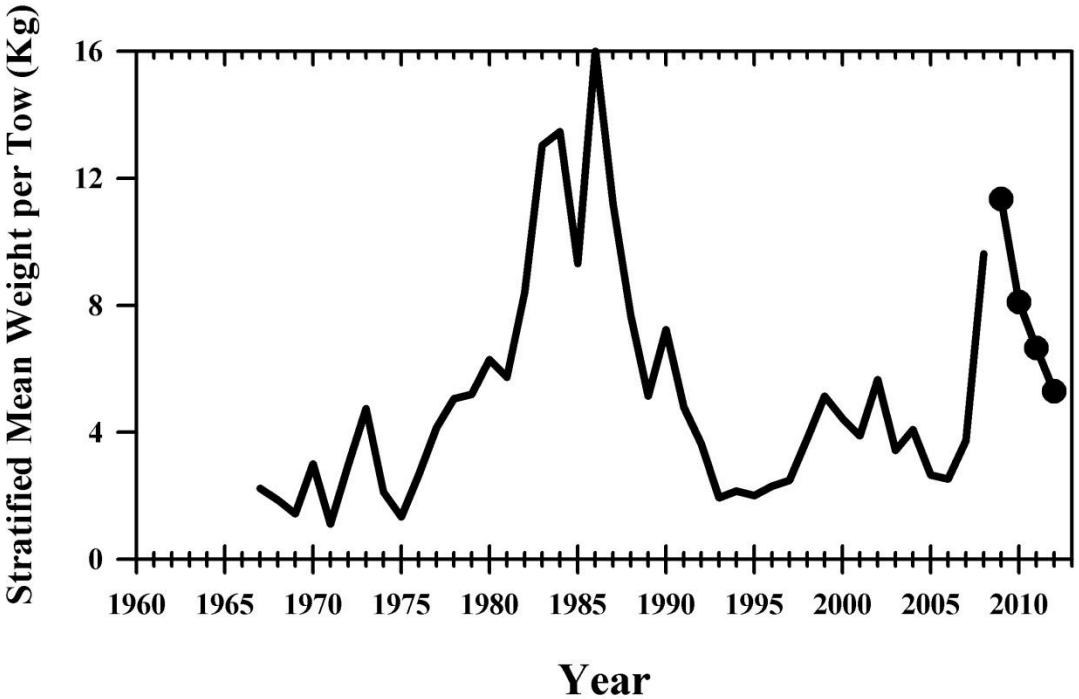

Figure 30. NEFSC autumn bottom trawl survey biomass indices for winter skate.

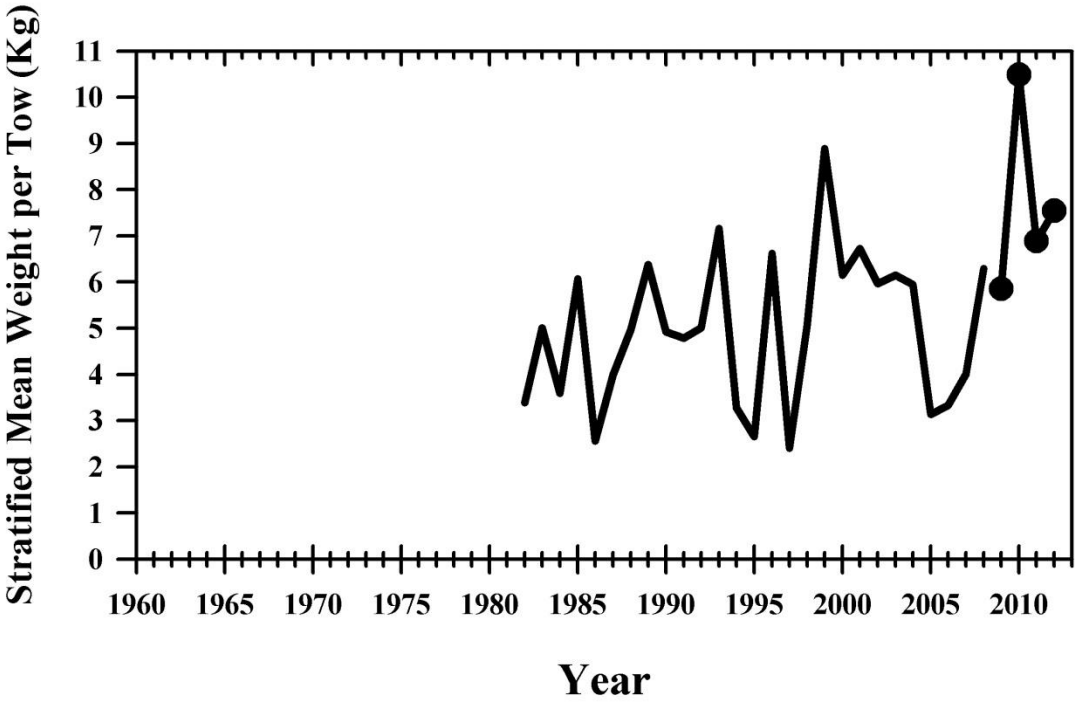

Figure 31. NEFSC spring bottom trawl survey biomass indices for little skate.

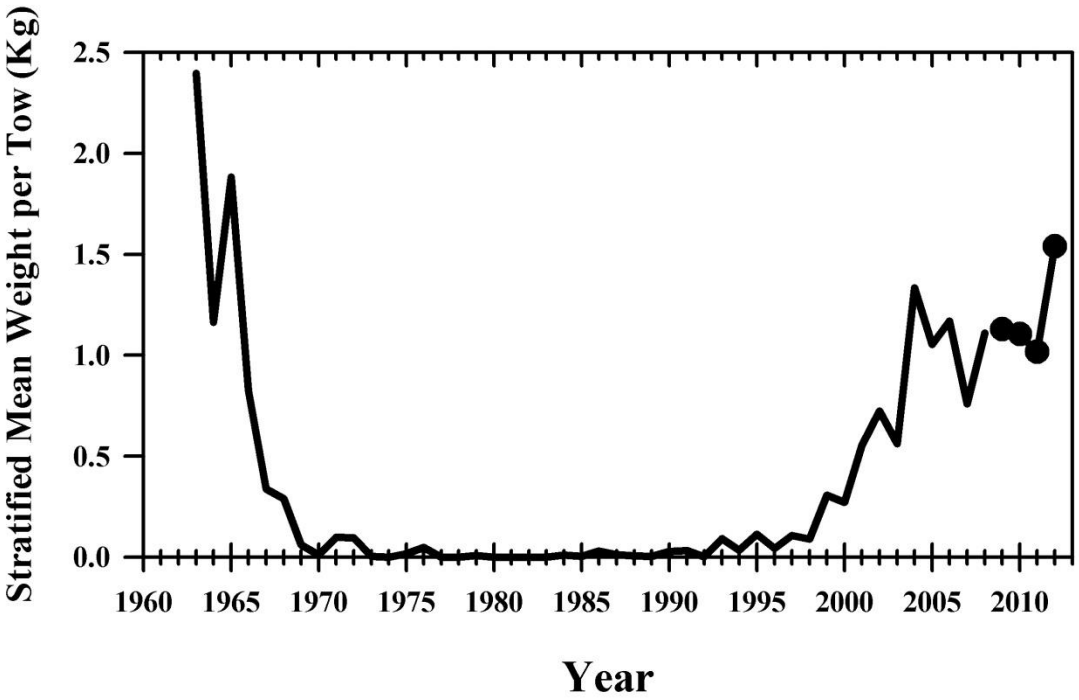

Figure 32. NEFSC autumn bottom trawl survey biomass indices for barndoor skate.

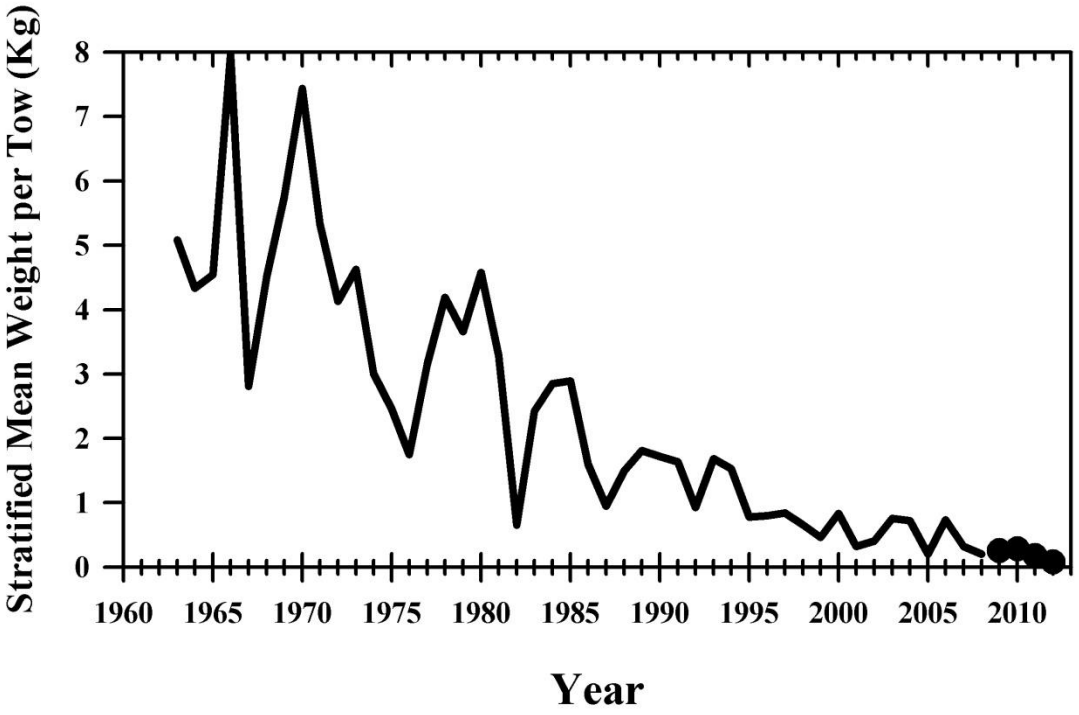

Figure 33. NEFSC autumn bottom trawl survey biomass indices for thorny skate.

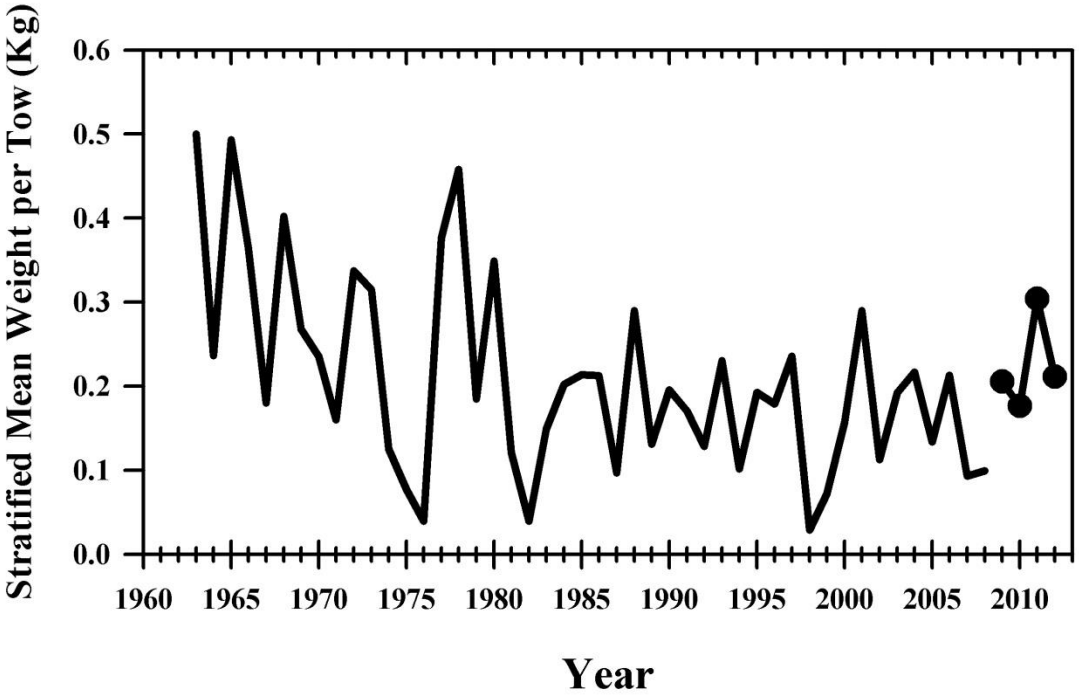

Figure 34. NEFSC autumn bottom trawl survey biomass indices for smooth skate.

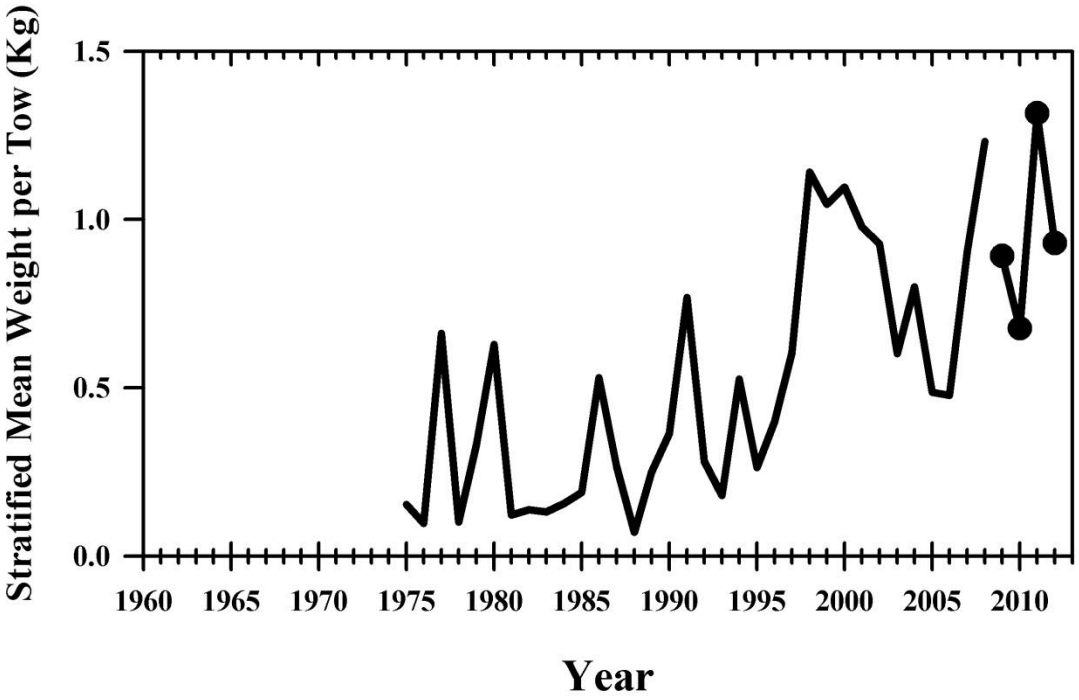

Figure 35. NEFSC autumn bottom trawl survey biomass indices for clearnose skate.

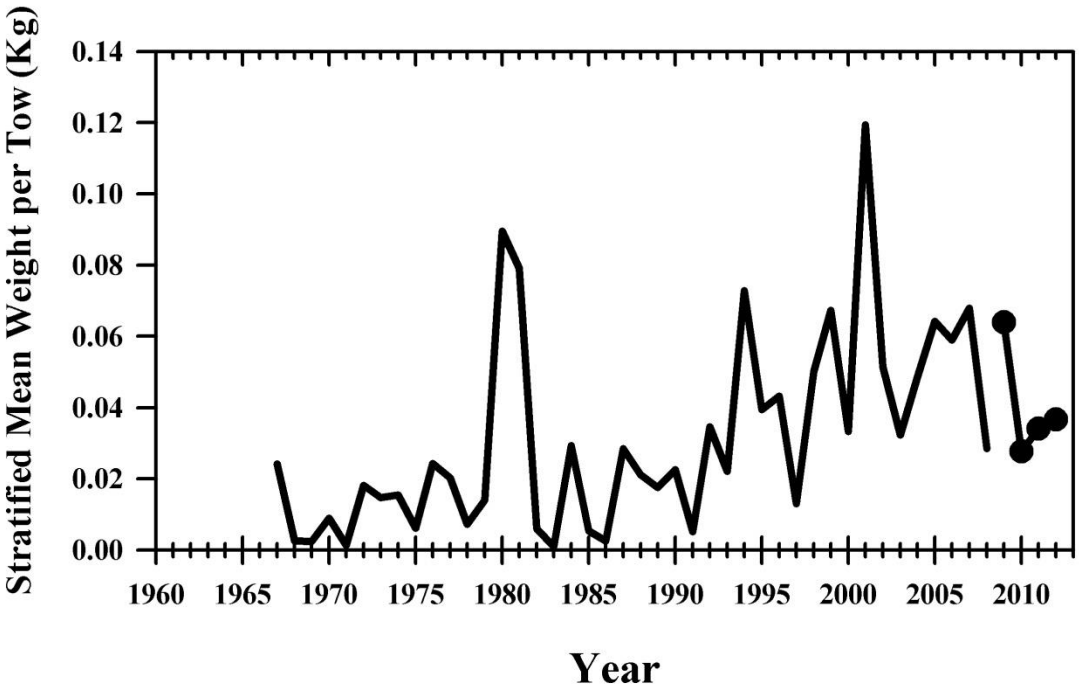

Figure 36. NEFSC autumn bottom trawl survey biomass indices for rosette skate.