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United States Research Report for 2009

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 in the Northeast Region can be found at http://www.nefsc.noaa.gov/sos/.

Revised sampling and reporting 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 therefore, the landings by area are still considered to be provisional. The procedures used since 2004 were not complete when this report was completed and therefore the landings by species among areas were not available for 2009.

The spring and autumn survey indices for 2009 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 the feasibility and estimation of such estimates have not yet been completed. Consequently, 2009 data points should be interpreted cautiously and these values may change in the future as new methodologies are considered. The 2009 data point has been plotted separately in each of the figures.

1. Atlantic Cod

USA commercial landings of Atlantic cod (*Gadus morhua*) from Subareas 5&6 in 2009 were 8,951 mt, a 3.5% increase from 2008 landings of 8,645 mt, and a 17% increase from the 7,679 mt landed in 2007. The information needed to generate stock-specific landings for 2009 were unavailable at the time of this report. USA cod landings in 2008, however, were 5,439 mt from the Gulf of Maine stock (Div. 5Y) compared to 3,206 mt from the Georges Bank stock (Div. 5Z and SA 6).

Northeast Fisheries Science Center (NEFSC) research vessel survey biomass indices for the Gulf of Maine stock gradually increased through 2001 following the 1993 record low. 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 NEFSC research vessel survey biomass indices for the Georges Bank stock have remained near record-low levels during 1991-2008, with the exception of an increase in the 2002 index, due primarily to a large catch at one station, and an increase in the 2004 index as a result of three large tows in three separate strata. The 2009 index, based on a preliminary conversion from FSV *Henry Bigelow* to RV *Albatross IV* units, was higher than that in 2008, but remains below the long term average (Figure 2).

2. Haddock

United States haddock (*Melanogrammus aeglefinus*) commercial landings decreased 9% from 6,352 mt in 2008 to 5,831 mt in 2009. The information needed to generate stock-specific landings for 2009 were unavailable at the time of this report. In 2008 Georges Bank (Div. 5Z) haddock landings were 5,744 mt. Gulf of Maine (Div. 5Y) haddock landings were 608 mt in 2008. Landings from both stocks are below historical levels.

The research survey vessel changed in 2009, and the estimated kg/tow with the new vessel was divided by a calibration factor of 1.489 to maintain equivalency with the existing time series. Autumn research vessel survey biomass indices decreased in 2009 for the Gulf of Maine stock but increased for the Georges Bank stock (Figures 3 and 4). The Georges Bank haddock stock biomass has increased sharply in recent years due to the exceptional 2003 year class. 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.

3. Redfish

USA landings of Acadian redfish (*Sebastes fasciatus*) increased by 22% from 1,190 mt in 2008 to 1,460 mt in 2009. Fall research vessel survey biomass indices have increased since 1996 (Figure 5) and are currently comparable to or greater than 1960s levels. The consistently high biomass indices reflect stock rebuilding and extremely low fishing mortality.

4. Pollock (4VWX + 5 stock)

USA landings of pollock (*Pollachius virens*) decreased from 9,964 mt in 2008 to 7477 mt in 2009. Research vessel survey indices indicated a moderate increase in pollock biomass in Subarea 5 from the mid-1990s through 2005 (Figure 6). In 2006, 2007 and 2008, however, the biomass indices declined sharply, to values last observed in the late 1990s. The biomass index for 2009 is the lowest observed in the time series, and is 12-13 times lower than the 2008 value. In addition to strong year effects that affect pollock catchability, a new survey vessel with new gear was used in 2009. Although pairwise tows were conducted for calibration, the fraction of tows where pollock were observed was too low to attempt a calibration for this species.

5. White Hake

USA landings of white hake (*Urophycis tenuis*) increased by 27% from 1,333 mt in 2008 to 1,697 mt in 2009. 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*) decreased 4% from 1,668 mt in 2008 to 1,606 mt in 2008. Research survey biomass indices in 2009 suggest that the Cape Cod-Gulf of Maine stock (Div. 5Y, N of Georges Bank) is slowly increasing due to the strong 2005 year class. The Georges Bank stock (Div. 5Z, E of 69W) is relatively high, while the Southern New England-Mid Atlantic stock (Div. 5Z W of 69W and SA 6) remains low (Figures 8-10).

7. Other Flounders

USA commercial landings of flounders (other than yellowtail flounder) from Subareas 3-6 in 2009 totaled 9,500 mt, 9% higher than in 2008. Summer flounder (*Paralichthys dentatus*) (51%), winter flounder (*Pseudopleuronectes americanus)* (23% comprising the Georges Bank, Southern New England and Gulf of Maine stocks), American plaice (*Hippoglossoides platessoides*) (15%), 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 2009. Compared to 2008,

commercial landings in 2009 were higher for American plaice (26%) and summer flounder (17%) but lower for windowpane flounder (- 33%), winter flounder (-6%), and witch flounder (-5%). Research vessel survey indices in 2009 increased for Georges Bank winter flounder, northern windowpane flounder and decreased for American plaice, summer flounder, and witch flounder (Figures 11-15).

8. Atlantic halibut

USA landings of Atlantic halibut (*Hippoglossus hippoglossus*) in the Gulf of Maine-Georges Bank region increased 40 % from 27 mt in 2008 to 38 mt in 2009. Research vessel survey indices have little trend and high interannual variability due to the low capture rates of Atlantic halibut. In some years, no Atlantic halibut have been caught indicating that abundance is at or below the detectability level of the survey (Figure 16).

9. Silver hake

USA landings of silver hake (*Merluccius bilinearis*) increased by 24% from 6,265 mt in 2008 to 7,759 mt in 2009. 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 2000, followed by a sharp decline in 2006. Subsequently, the indices have generally increased (Figure 17). Survey indices for the Southern Georges Bank - Mid-Atlantic stock have also increased since 2007 but over a smaller range (Figure 18).

10. Red Hake

USA landings of red hake (*Urophycis chuss*) remained stable at 591 mt in 2008 and 586 mt in 2009. Landings have remained low since 1980. Research vessel survey biomass indices for the Gulf of Maine - Northern Georges Bank stock increased steadily after the early 1970s, markedly declined in 2004-2005, and have since increased slightly (Figure 19). Indices for the Southern Georges Bank - Mid-Atlantic stock, however, continue to remain low (Figure 20) despite low landings.

11. Atlantic Herring

Total USA landings of Atlantic herring (*Clupea harengus*) increased 26% from 82,578 mt in 2008 to 103,942 mt in 2009. Spring survey indices increased during the 1990s and averaged 2.48 kg/tow during 2001-2008 (Figure 21). The 2009 spring survey index was 2.28 kg/tow. Spawning biomass increased from 1982 to 1997 and has remained stable since 1998. SSB was estimated to be 515,600 mt in 2008. Recent assessments, however, have been plagued by a strong retrospective pattern.

12. Atlantic Mackerel

USA commercial landings of Atlantic mackerel (*Scomber scombrus*) increased 4% from 21,728 mt in 2008 to 22,669 mt in 2009. Recreational catches increased 8% from 691 mt in 2008 to 747 mt in 2009. Spring survey indices increased during the 1990s and averaged 9.3 kg/tow during 2001-2008 (Figure 22). The 2009 spring survey index was 13.9 kg/tow. Results of an assessment of Atlantic mackerel were reviewed in 2010 by the Transboundary (US and Canada) Resources Assessment Committee (TRAC). The TRAC concluded that the abundance estimates were too uncertain for management purposes but that relative trends in F and SSB were informative.

13. Butterfish

USA landings of butterfish (*Peprilus triacanthus*) decreased 4% from 451 mt in 2008 to 434 mt in 2009. Fall research vessel survey biomass indices have fluctuated substantially since the 1970s, but were generally highest in the late 1970s and early 1980s. Since the early 1990s, annual survey values have generally declined, with the most recent indices among the lowest in the survey time series (Figure 23).

14. Squids

Since 2005, USA landings of longfin inshore squid (*Doryteuthis (Amerigo) pealeii*, formerly *Loligo pealeii*) have been declining and totaled 9,255 mt during 2009, 23 % lower than in 2008 (11,418 mt). The autumn survey abundance index declined from a record high in 2006 (1,509 squid per tow) to 1,038 squid per tow in 2009 (Figure 24).

USA landings of northern shortfin squid (*Illex illecebrosus*) during 2009 totaled 18,418 mt, 14 % higher than in 2008 (15,900 mt). The autumn survey abundance index attained a record high in 2006 (29.5 squid per tow) but has since declined to 8.1 squid per tow in 2009 (Figure 25).

15. Sea Scallops

USA sea scallop (*Placopecten magellanicus*) landings in 2009 were 26,129 mt (meats), slightly higher than in 2008, and more than twice the long-term (1957-2009) average. About 25% (6,475 mt meats) of the 2009 landings was harvested from Georges Bank, whereas 74% (19,350 mt meats) was taken from the Mid-Atlantic. Since 2000, most of the annual landings have come from the Mid-Atlantic region, except during 2006. By contrast, during 1957-1999, most USA sea scallop landings were from Georges Bank.

Research vessel survey biomass indices in 2009 showed little change from 2008, and remained high by historical standards (Figures 26 and 27). Recruitment was above average on Georges Bank, but below average in the Mid-Atlantic. Georges Bank recruitment during 2008-2009 was the highest observed since 2000-2001. However, in the Mid-Atlantic region, recruitment in 2009 was the lowest observed since 1997.

16. Northern Shrimp

USA commercial landings of Northern shrimp (*Pandalus borealis*) from Subarea 5 in 2009 were 2,163 mt, a 30% decrease from the 2004-2008 annual average of 3,111 mt and a 83% decrease from the record-high 12,824 mt landed in 1969.

The joint state federal summer research vessel (Gloria Michelle) survey biomass indices declined during 1985 through 2004. A sharp increase occurred in 2006; however, the survey in this year was considered less reliable due, in part to a low number of tows. Biomass indices subsequently have declined, although the 2009 index is still above the 1985-2005 average (Figure 28).

17. Small Elasmobranchs

USA landings of spiny dogfish (*Squalus acanthias*) increased 27% from 4,105 mt in 2008 to 5,215 mt in 2009, due to increases in quotas. 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 still landed as unclassified) decreased by 4% between 2008 and 2009 from 18,604 mt to 17,789 mt. The landings are sold as wings for human consumption and as bait for the lobster fishery. 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 1990s. During the 1990s, the indices stabilized at an intermediate level, but increased markedly in recent years. Little skate (*Leucoraja erinacea*) survey indices have generally fluctuated without trend (Figure 31). Survey indices for barndoor skate (*Dipturus laevis*) declined precipitously 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 near 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. The indices for clearnose skate declined between 2001 and 2006, but sharply increased in both 2007 and 2008 (Figures 35 and 36).

B. Special Research Studies

1. Environmental Studies

a) Hydrographic Studies

A total of 1627 CTD (conductivity, temperature, depth) profiles were collected and processed on Northeast Fisheries Science Center (NEFSC) cruises during 2009. Of these, 1613 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. CTD data from 4 cruises conducted in 2009 remain to be processed. When these data are processed they will be added to the oracle database and cruise reports will be accessible at the same website.

b) Plankton Studies

During 2009, zooplankton community distribution and abundance were monitored using **665** bongo net tows taken on **six** surveys. Each survey covered all or part of the continental shelf region from Cape Hatteras northeastward through the Gulf of Maine. The Ship Of Opportunity Program (SOOP) completed **13** transects across the Gulf of Maine from Cape Sable, NS to Boston, and **14** transects across the Mid-Atlantic Bight from New York to the Gulf Stream.

c) Benthic Studies

The NEFSC's James J. Howard and Woods Hole Laboratories, U. S. Geological Service (USGS), and several collaborating academic institutions (see below) conducted an extensive field program to develop methods for mapping, characterizing and developing hypotheses regarding benthic habitats and their macrobenthic and demersal communities during 2009.

A 10 day cruise was conducted during February, 2009 for the purposes of training students in the NOAA Living Marine Resources Cooperative Science Center (LMRCSC) program and conducting joint research projects with NMFS and LMRCSC faculty from the University of Maryland Eastern Shore. Scientific findings included the following:

- Sampling the outer continental shelf and slope around Hudson Canyon has continued to confirm a the pattern perceived from earlier cruises 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. Catch, hydrographic, sedimentological, and visual (photo and video) data are being analyzed ashore to elucidate this pattern and understand what conditions cause fisheries resource species to behave in this way. Short term hydrological variation overlaying seasonal patterns are strongly suspected as the principal driver for the observed ecosystem patterns.
- For the first time in this cruise series otter trawling was performed at 300 and 1000 m depths in the vicinities of Norfolk and Hudson Canyons to assess the depth distributions of monkfish (*Lophius americanus*), deep sea red crab (*Chaeceon quinquidens*) and witch flounder (*Glyptocephalus cynoglossus*). The latter two species dominated catches at all depths, but monkfish distribution was restricted to the shallower stations; samples of this species were sampled for size, weight, age, sexual maturity, and diet, and samples were taken for reproductive histology, genetic and stable isotope analyses. Other deepwater species captured of possible fisheries interest included porcupine king crab (*Neolithodes garibaldi*) and gamba prawn (*Aristaeopsis edwardsiana*).
- Comparison was made of catches from side-by-side tows with an 11 m otter trawl (Yankee 36 standard NEFSC survey trawl) and 2 m beam trawl at 13 sites on the continental shelf between New Jersey and North Carolina for purposes of developing better sampling methods for assessing macrobenthic/demersal community structure and biodiversity. Catches of most species were smaller than in the previous year, except for spiny dogfish and Atlantic mackerel. Of 74 total species captured, 37 were caught exclusively in the beam trawl, 37 were caught by both methods, and 12 were caught exclusively with the Yankee 36. As previously, we found that biodiversity is greatly underestimated

by the use of either method alone, but especially if only Yankee 36 is used. Work with multiple sampling methods for better definition of ecological properties continues.

- For the second winter in a row, juvenile southern white shrimp (*Litopenaeus setiferus*) were captured off Virginia, well north of their usual wintertime distributional limit (Cape Hatteras). This attributable to relatively mild winter water temperatures.

A 12 day cruise was conducted during early August, 2009 in cooperation with USGS in order to investigate the hydrographic regime along the northern tier of Georges Bank and its relationship to the distribution of bottom habitats. In particular, the focus was on the relationship of hydrography to the distribution of the invasive colonial tunicate *Didemnum vexillum*, the monitoring of areas not yet colonized by the tunicate on both sides of the U.S.-Canadian border and both inside and outside of areas closed to bottom fishing in the U.S., and areas in the U.S. of unknown habitat type and status.

- Sampling methods utilized on this cruise included transects with the USGS Seaboss drift video/photo vehicle and hydrographic profiling with a two CTDs, one attached to Seaboss and one deployed on a vertical hydrowire.
- Spatio-temporal patterns of bottom and water column temperature over tidal cycle timescales were characterized for several locations (east to west) along the U.S. side of the northern tier of Georges Bank. Some benthic habitat areas were found to experience semidiurnal cyclic temperature changes of as much as 6° C at rates of up to 4° C per hour. The intensity of these fluctuations decreased north to south, i.e. they were most intense along the border between the bank and the Gulf of Maine to the north and decreased southward toward the interior of the bank. The high-density, high-diversity "pristine" habitat supporting continuous cover with the bryozoan *Eucratia loricata* was largely restricted to the northeast corner where tidal temperature changes were largest and the bottom had experienced no trawling disturbance for several years.
- *D. vexillum* did not occur in areas of strong tidal temperature fluctuations and substrate coverage by this tunicate was highest inside Closed Area II, presumably for lack of disturbance by trawling.
- A number of differing habitat types were visually surveyed on the northern tier of the bank; habitat types changed visibly on the scales of hundreds of meters. Thus the northern tier appears to represent a complex of habitats, rather than a single type.
- Sub-adult to adult cod and probable juvenile cod were repeatedly seen in the "pristine habitat" area. Juvenile cod also occurred immediately south, but were largely absent from areas dominated by *D. vexillum*. Haddock and silver hake were widespread in CA II, even where the bottom was dominated by *D. vexillum.* Gadoids were less often seen outside CA II than inside. Sea scallops occurred virtually everywhere at the eastern end of Georges Bank, inside and outside, with or without *D. vexillum*. No scallops and only a few silver hake were seen in area 24 in the west.

Regarding the rugged rim area on Georges Bank, gravel habitat with a high biodiversity of benthic species serve as nursery grounds and provide a rich source of prey for bottom-feeding fish such as cod, haddock, and flounder. Comparison of gravel habitats in an area closed to fishing (Closed Area II) to nearby similar habitats that are being actively fished have shown that there has been little recovery in the closed area in 14 years. Benthic fauna such as sponges, bryozoans, hydrozoans, tube worms, and other species remain sparse on the disturbed seabed. In fact, until now there has been no "pristine" gravel habitat in the U.S. part of Georges Bank against which the currently impacted and "recovering" habitats could be compared. Until recently, the only known undisturbed gravel was on the Canadian part of the bank. In late 2007, an area was discovered in Closed Area II that appears never to have been affected by dredging and trawling based on the rich assemblage of fragile attached species observed there, on the presence of abundant cod and haddock, and on the absence of disturbed seabed. Additional small patches were discovered on the U.S. side of Georges Bank in 2009.

A 9 day cruise was conducted in late August, 2009 in order to investigate both benthic and pelagic habitat conditions in Hudson Canyon, off New Jersey, a local fishing "hot spot" for both commercial and recreational fisheries and a feature being considered for designation as a Habitat Area of Particular Concern (HAPC). High resolution mapping of portions of the canyon was performed using AUV-mounted multibeam sonar. Near-synoptic CTD profiles were collected for the entire shelf and adjacent upper slope portions of the canyon head region, including water samples for methane analysis.

- Bottom mapping was accomplished for approximately 48.5 km^2 of Hudson Canyon at very high resolution with the use of the National Institute of Undersea Science and Technology (NIUST) AUV "Eagle Ray" equipped with multibeam sonar.
- Participating investigators hailed from NEFSC, the University of Southern Mississippi, Rutgers University, Richard Stockton University, and the State University of New York at Stony Brook.
- Onboard post-processing of Eagle Ray multibeam data produced bathymetric, backscatter, and slope maps with about 2 m horizontal resolution, far exceeding that of any previous mapping effort in Hudson Canyon. Previously unknown features revealed included steep, high backscatter cliffs that resemble those know to harbor deepwater soft coral communities in New England, crater-like depressions that probably represent regions of methane release from buried gas hydrate deposits, and linear patterns high-backscatter pockmarks that suggest substantial microbial chemosynthesis, probably methane-based that may also support deepwater epifaunal communities. Previously poorly defined features whose boundaries were made sharp and clear include outcrops of semi-lithified clay in canyon walls and the characteristic hummocky microtopography thought to be created by a long history of burrowing by golden tilefish (*Lopholatilus chamaeleonticeps*). The presence and location of such habitats, which may be deemed Vulnerable Marine Ecosystems (VME), are necessary for any HAPC designation. Photographic transects of these will be undertaken with another NIUST AUV (Mola Mola) in 2010.
- A CTD/water sampling pattern concentrating on the central portion of the canyon again demonstrated strong and complex vertical and horizontal gradients in temperature and salinity associated with the canyon.
- Water samples for locating sources of deepwater dissolved methane concentrations were taken in the central area of the canyon, particularly in the vicinities of crater-like bottom features. Results strongly suggest the presence of cold methane seeps, which likely support chemosynthetic communities. Both the presence of such seeps and any associated communities await further sampling and visual confirmation in 2010.

2. Biological Studies

a) Fish Species

Flatfishes: We are currently analyzing the relative roles of the environment and of parentage to offspring quality and viability from an experimental study on winter flounder, *Pseudopleuronectes americanus*. Such information is important for a thorough understanding of recruitment patterns as well as the aquacultural potential of a species. The data are derived from an experiment that was designed to evaluate the relative contributions of paternal, maternal, and thermal contributions to early life-history traits of their offspring. Responses were scored from embryonic development through larval life and into juvenile life-stage, culminating with gender expression. Preliminary analyses of these data show the relative ranking of families (sib-groups) in regards to their growth and developmental rates to change with the environment. Such environmental dependency affects the notion of preferred or optimal phenotype in nature or aquaculture because such a determination will depend on the environmental context. We are undertaking a new study on relationship between maternal attributes (age, size) and offspring quality (attributes of eggs, embryos, larvae, and young juveniles) in summer flounder, *Paralichthys dentatus*. That work is in cooperation with other federal and academic scientists in the mid-Atlantic region of the USA.

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 (F_1 and F_2) tomcod populations; and 3) interactions between environmental stressors, i.e., PCBs and high summer temperatures. The toxicological work in 2008-09 included an assessment of 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). Collaborations in 2007-09 with colleagues at New York University and at University of Maryland Eastern Shore include evaluating the incidence of tumors in laboratory-reared F_1 juveniles exposed as embryos to combinations of PAHs and PCBs, and larvae / juveniles exposed to PCBs via contaminated brine shrimp as food. We recently completed the 13-mo grow out period and sacrificed the adults for body size, gonad size, liver size, and preserved samples for histological evaluation of their livers and biochemical analyses of their ovaries with respect to their exposure history. We also continued an assessment of effects of nanoparticles on tomcod early life-stages in order to get a measure of effects of type and dose of commonly manufactured nanoparticles.

Sturgeons: We began pilot eco-toxicological studies in 2009 on shortnose and Atlantic sturgeons (*Acipenser brevirostrum* and *A. oxyrhynchus*, respectively). Toxic responses of eggs and larvae are being 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. In 2010 we expect to conduct evaluations of the toxicities to sturgeons of individual congeners and Aroclor mixtures.

Fish Barcode of Life: As part of the Fish Barcode of Life initiative (www.FISHBOL.org), tissue samples of up to 5 individuals per species were collected, mostly from fishes caught during fishery surveys by the Northeast Fisheries Science Center (NEFSC). The barcode is a 650 basepair segment of the mitochondrial cytochrome *c* oxidase (COI) gene. Most of the voucher specimens have been deposited at the National Museum of Natural History (USNM). This project will be of direct benefit to NEFSC and NMFS once we have built a COI database of most of the fish species occurring in the region. 1) Barcoding works for all stages in the life cycle so barcoding will assist in identification of larval fishes. This is particularly important because most of the NMFS leaders in "larval fish taxonomy" have retired leaving us with identification problems. 2) Barcoding usually differentiates between closely related species that are difficult to distinguish such as the hakes (*Urophycis*) or silver hakes (*Merluccius*). Barcoding is particularly useful for large specimens that are difficult to bring back for identification. 3) Barcoding can positively identify fishery products such as fish fillets. 4) Barcoding can legally verify identifications of fishes caught as by-catch and species under regulation. 5) Barcoding is useful in identifying stomach contents. Currently, tissues have been collected from 600 specimens representing 180 species, 158 genera, and 96 families. This includes more than 100 species from the Gulf of Maine out of a fauna of 252 species plus many species from nearby in the western North Atlantic.

b) Resource Survey Cruises

During 2009 personnel from the Ecosystems Surveys Branch (ESB) staged, staffed and supported the spring and fall multispecies bottom trawl, and northern shrimp trawl surveys. Additional staff and gear support was provided for the sea scallop dredge, Atlantic herring hydroacoustic, non-ESB and cooperative (monkfish, paired trawl and twin-trawl) surveys for a total of 326 research and charter vessel sea days. NOAA scientific and contract staff participated on these various cruises for a total of 2504 staff sea days and volunteers contributed another 656 person sea days. ESB cruises occupied 1992 stations in an area extending from Cape Hatteras, North Carolina to Nova Scotia including the Gulf of Maine. A total of 2,125,689 length measurements were taken from 392 species during these cruises. Ecosystem survey data currently is utilized as fishery independent abundance or biomass inputs for 48 single species stock assessments and several ecosystem dynamics modeling efforts.

Significant sampling effort was also expended to fulfill requests from 41 NOAA and University investigators for samples or observations made during the various survey cruises. These included 24,014 feeding ecology observations, 31,682 aging structures removed, and 21,771 samples or individual

specimens collected to support additional shore based research.

c) Age and Growth

Approximately 58,000 age determinations for 11 species of finfish were completed in 2008 by Woods Hole Laboratory staff in support of resource assessment analyses. In addition to Atlantic cod (3,137), haddock (8,166), and yellowtail flounder (7,467), 9,842 summer flounder, 4,742 pollock, and 7,177 butterfish were aged. Age determinations for Atlantic herring, winter flounder, scup, goosefish, and Atlantic mackerel totaled 17,038.

Cod and haddock age structures were exchanged with age readers from Fisheries & Oceans Canada St. Andrews Biological Station in a continuing effort to maintain comparability of age determinations between laboratories. Summer flounder age structures were exchanged with age readers from the Virginia Institute of Marine Science as the basis for a reference collection for the species and in preparation of an ageing workshop in 2010.

A project comparing survey length and age compositions for several species collected by the outgoing Fisheries Research Vessel Albatross IV and incoming FRV HB Bigelow was conducted. Research projects continued in 2009 included: (1) a broad study to enumerate current fecundity levels of multiple groundfish species; (2) histological sampling to calibrate macroscopic gonad staging performed during research vessel survey cruises; (3) a study examining growth chronologies in Acadian redfish; (4) an age validation study of Atlantic surfclams using sectioned chondrophores obtained from samples collected across the geographic range of the species; and (5) a study investigating the feasibility of measuring bioelectrical impedance (BIA) as a predictor of fish condition and reproductive potential. New projects initiated in 2009 included: (1) enhanced biological sampling of three species of flatfish to examine monthly aspects of diet, reproductive biology, and condition; and (2) an experimental study examining reproductive biology and condition of a protogynous hermaphrodite, black sea bass, at varying ration levels.

d) Food Web Dynamics

The NEFSC continued studies of 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 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 2009 spring and autumn surveys, 11,128 stomachs from 55 species, and 8,141 stomachs from 56 species were examined respectively. Diet sampling emphasized small pelagics, elasmobranchs, gadiformes, flatfishes, and lesser known species.

The 37 year time series (1973-2009) 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 600,000 stomach samples. The processing of the 2009 bottom trawl survey food habits data is scheduled for completion in 2010.

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 fish production, fisheries reference points, system-wide productivity, and essential fish habitat.

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 2009. Information was received on 7,250 tagged and 325 recaptured fish bringing the total numbers tagged to 216,000 sharks of more than 50 species and 12,850 sharks recaptured of 33 species.

The bi-annual fishery independent survey of Atlantic large and small coastal sharks in US waters was conducted in the spring of 2009. The goals of this survey are to: 1) monitor the species composition and sizes, distribution, and abundance of sharks in the coastal Atlantic; 2) tag and inject sharks for age validation and migration studies; 3) collect biological samples for age and growth, feeding ecology, and reproductive studies; and 4) collect morphometric data for size conversions. The time series of abundance indices from this survey are critical to the evaluation of coastal Atlantic shark species. Results from this 2009 survey included 1,686 fish (1,676 sharks) representing 19 species. Sharks represented 99% of the total catch of which sandbar sharks were the most common, followed by dusky and tiger sharks. As part of this survey, bottom longline sets were conducted in the closed area off North Carolina. Cooperative work included sample collections of blood, heart and other tissues for post-release survivorship, parasite, toxicology, and ribosomal DNA species identification marker studies.

Pelagic shark biology, movements, and abundance studies continued in 2009 with further investigations of pelagic nursery grounds in conjunction with the high seas commercial longline fleet. This collaborative work offers a unique opportunity to sample and tag blue sharks and shortfin makos in a potential nursery area and to collect length-frequency data, biological samples, and conduct conventional and electronic tagging of these species. Thus far over 1,800 sharks have been tagged 83 were recaptured. These fish were primarily blue sharks that were recovered by commercial fishermen working in the mid-Atlantic. In addition, 250 blue sharks were double tagged to help evaluate tag-shedding rates used in sensitivity analyses for population estimates and to estimate fishing mortality and movement rates for this pelagic shark species.

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 2009, our COASTSPAN participants were the Georgia Department of Natural Resources, the South Carolina Department of Natural Resources, Coastal Carolina University, North Carolina Division of Marine Fisheries, and the University of North Florida. The NEFSC staff conducts the survey in Narragansett and Delaware Bays and limited exploratory sampling in Massachusetts in conjunction with Massachusetts Division of Marine Fisheries (MDMF). NEFSC and MDMF staff also conduct a survey in the U.S. Virgin Islands (USVI) using COASTSPAN gear and methods. Habitat utilization and essential fish habitat studies of Delaware Bay and Massachusetts sand tigers progressed with the use of satellite and passive acoustic telemetry in 2009. Relative indices of abundance from the Delaware Bay COASTSPAN survey were created for use in a 2009 publication updating the status of the U.S. sand tiger population. In addition, data obtained from this survey were used in a 2009 publication detailing a cooperative genetic study on sandbar sharks with the Virginia Institute of Marine Science, which calculated the effective number of breeders and effective population size for adults of Delaware Bay and the Eastern Shore of Virginia.

NEFSC staff recently recovered the shark species catch per set data from the exploratory shark longline surveys conducted by the Sandy Hook and Narragansett Laboratories from 1961 to 1991. This recovery is part of a larger project to electronically recover and archive historical longline surveys and biological observations of large marine predators (swordfish, sharks, tunas, and billfishes) in the North Atlantic. Standardized indices of abundance from this time series were created using a delta-Poisson generalized linear model for the sand tiger for use in a 2009 publication detailing the status of the U.S. sand tiger population. Work on the recovery of additional data for this time series, as well as the associated individual shark data, is ongoing to further refine these indices, develop indices of abundance for other shark species, and for future use in shark stock assessments and EFH designations.

f) Marine Mammals

Small Cetaceans:

During August 3-17, 2009, the NEFSC conducted a shakedown cruise on the *NOAA Ship Henry B. Bigelow* to prepare for a 60-day 2010 abundance survey for marine mammals, sea turtles, and sea birds. The 2009 study area included the region within the US Exclusive Economic Zone north of 37°N latitude, to the southern flank of Georges Bank, about 41°N, and between approximately the 100 m depth contour and the Gulf Stream. During daylight hours while traveling at about 11 knots during good weather (less than Beaufort sea state 5) approximately 1010 nmi of track lines were completed. During this time, data were collected on the following: visually detected marine mammals and sea turtles from two independent teams; acoustically detected animals from a passive acoustic hydrophone array that was trailed behind the ship; hydrographic features such as sea surface temperature and depth that were continuously recorded from the ship's onboard sensors and from sampling stations where a CTD was deployed to about 500 m depth; and plankton which were collected from bongo tows that were deployed up to three times a day. From one visual team, the following numbers of animals were detected: 73 striped dolphins (*Stenella coeruleoalba*), 16 beaked whales (*Mesoplodon* spp or *Ziphius* spp), 396 bottlenose dolphins (*Tursiops truncatus)*, 367 Risso's dolphins (*Grampus griseus*), 6 killer whales (*Orcinus orca*), 6 leatherback turtles (*Dermochelys coriacea*), 5 loggerhead turtles (*Caretta caretta*), 57 common dolphins (*Delphinus delphis*), 147 pilot whales (*Globicephala* spp) , 16 fin whales (*Balaenoptera physalus*), 1 sei whale (*Balaenoptera borealis*) , 4 fin or sei whales, 47 sperm whales (*Physeter macrocephalus*), 1183 Atlantic striped dolphins (*Stenella frontalis*), and 37 white-sided dolphins (*Lagenorhynchus acutus*). During night time hours, additional plankton data were collected from the active acoustic EK60, a neuston net, and a Visual Plankton Recorder (VPR) that was deployed on the same track lines that were surveyed during the daytime by the marine mammal teams. A total of 11 vertical CTD profiles, 25 double oblique CTD with bongo hauls, 8 CTD with neuston net hauls, and 24 CTD with VPR hauls were conducted.

During August 4-15, 2009, the NEFSC conducted an aerial distribution survey and an experiment on the NOAA aircraft Twin Otter where sea turtles and coastal bottlenose dolphins were the target species, though all detected marine mammals were recorded. The plane flew at 600 feet altitude at about 110 knots. The study area was the mid-Atlantic coastal waters between New York (41° 30'N) and North Carolina (36° 30'N) and between the coast line and the 50 m depth contour (about 20-25 nmi offshore), where most of the effort was within 6 nmi of the shore line. The objective of the experiment was to determine the minimum sized turtle that can easily be detected during an aerial abundance survey at various distances from the track line. This was accomplished in Long Island Sound by setting out floating models of various sized turtles at various distances from a track line that the plane flew over. During about 13 hours of experimental flights, it was determined that turtles that were greater than 40 cm diameter could easily be detected, though some animals smaller than this were detected. The objective of the abundance survey was to describe the spatial distribution of different sized turtles in Mid-Atlantic coastal waters in state versus federal waters using two independent teams of observers in the plane. In about 3400 nmi of track lines, from one team the following was detected: 336 loggerhead turtles (*Caretta caretta*), 61 green turtles (*Chelonia mydas*), 3 Kemp's Ridley turtles (*Lepidochelys kempii*), 7 leatherback turtles (*Dermochelys coriacea*), and 1376 bottlenose dolphins (*Tursiops truncatus)*.

Incidental bycatches of cetacean, turtle, and seal species were estimated based on observed takes in commercial fisheries from Maine to North Carolina. Fisheries observed during 2009 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 (*Phocoena phocoena*), Risso's dolphins, common dolphins, Atlantic white-sided dolphins, and pilot whales. To support Atlantic Take Reduction Teams (e.g., harbor porpoise, coastal bottlenose dolphin, and Atlantic trawl teams), the observer data were investigated to identify environmental factors, fishing practices, or gear characteristics associated with the bycatches. The NEFSC has been working with the gillnet fishery to reduce harbor porpoise bycatch. In 2009 the first half of a study was completed that compared the bycatch rates of harbor porpoise in two gillnet configurations (hung at 0.5 versus hung at 0.33). The contract for the second half of the project was awarded and is near completion.

Large Cetaceans:

During 18 June-7 July, 2009, a survey was conducted aboard the NOAA R/V Delaware II. The objective of this cruise was to collect skin samples from various odontocetes for purposes of informing stock definitions. The primary target was white-sided dolphins throughout the Gulf of Maine and along the Scotian shelf. Secondary targets included offshore odontocetes in warmer offshore waters south of Georges Bank such as striped, spotted and offshore bottlenose dolphins.

A baleen whale acoustic ecology and habitat sampling cruise was conducted on the NOAA R/V Delaware II between 13 and 30 July 2009. The primary survey area was the Stellwagen Bank National Marine Sanctuary (SBNMS) with additional survey lines and acoustic sampling work in the larger Gulf of Maine. The primary objectives were to 1) determine day and night time spatial distribution of baleen whales and their prey throughout the National Oceanographic Partnership Program (NOPP - http://www.nopp.org/) acoustic array, located in the Southwest portion of the SBNMS, 2) deploy, calibrate and synchronize the NOPP acoustic array, for acoustic localization purposes, 3) collect visual sightings of baleen whales on anchor stations within the NOPP acoustic array to inform and validate acoustic recordings, and 4) collect photo ID, acoustic recordings and biopsies of baleen whale groups in the larger Gulf of Maine. Primary target species were minke whales with sei and fin whales as secondary target species.

The North Atlantic Right Whale Sighting Survey (NARWSS) is a NMFS program dedicated to identifying and documenting the locations of right whales (*Eubalaena glacialis*) off the northeastern United States. All NARWSS flights conducted in 2009 were systematic surveys and followed track lines within nine survey blocks: Cashes Ledge, Franklin Basin, Georges Basin, Georges Shoal, Great South Channel, Howell Swell, Jeffreys Ledge, Jordan Basin, and Stellwagen Bank. During 2009, 66 flights that involved 330 flight hours were conducted in these survey blocks. In addition, there was one directed flight to relocate a whale carcass. The total number of right whales seen on the aerial surveys (tally of estimated group size, not the number of unique individuals identified from photographs) was 584.

During January - March 2009, 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 from an inflatable boat. The DNA in the 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 June 2010, NEFSC has been involved in an ocean noise project in the Stellwagen Bank National Marine Sanctuary. This project aims to characterize the underwater acoustic environment of the sanctuary and further examine the effects of noise on resident marine animals. The work is carried out in collaboration with NOAA Sanctuaries, Cornell University and Marine Acoustics Inc. Marine autonomous recording units (MARUs) have been deployed in the sanctuary to record low-frequency underwater sound. Information regarding the distribution of anthropogenic and natural sources of underwater noise (including vocally-active whales and fish) and information from ongoing whale tagging efforts are being used to better understand whether and how animals change their behaviors in noisy environments. Parts of this work have recently been published in a Theme Section in Marine Ecology Progress Series (http://www.int-res.com/abstracts/meps/v395/).

Another passive acoustics project initiated in 2008 at the NEFSC is aimed at validating passive acoustic techniques. This project is in collaboration with the Massachusetts Division of Marine Fisheries and Cornell University. The objective of the program is to understand the acoustic ecology of the marine animal species in the NE region and how animals use sound over different time and regional scales, seasons, individual, sex and behavioral contexts. Aerial and visual survey data are being used to validate and confirm acoustic events, as well as to model and predict call patterns and usage. This information will then

be integrated into available sensor capacities including fixed and mobile acoustic sensors which report either in an archival or real time fashion. The last step will allow us to improve management and monitoring sampling regimes so as to utilize passive acoustics to its best capacity.

Other ongoing work includes the deployment of a towed hydrophone system during marine mammal abundance cruises. High-frequency and mid-frequency acoustic data are being collected in order to detect, identify and track groups of marine mammals. Results will be compared to visual data and help in assessments of marine mammal abundance.

Scarification analyses of right and humpback whales continued in 2009. 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: Aerial monitoring of major harbor seal and gray seal haul-out sites in southern Massachusetts was continued in 2009. Likewise, major gray seal pupping colonies in Massachusetts and Maine coastal waters were surveyed. Fifteen aerial seal surveys were conducted, with 12 conducted in Massachusetts and 3 in Maine.

g) Turtles

The NEFSC collaborated with academics, industry groups, and researchers from other NMFS science centers to assess and reduce sea turtle bycatch in U.S. commercial fisheries in the Northwest Atlantic Ocean. In 2009, research efforts were focused on Mid-Atlantic bottom trawl fisheries, Mid-Atlantic sea scallop fisheries, and Mid-Atlantic gillnet fisheries.

The NEFSC awarded contracts for five new conservation engineering studies that focus on Sea Turtle issues; (1) TED testing in scallop trawl fishery; (2) TED testing in flounder trawl fishery;(3) TED testing in the whiting fishery; (4) TED testing in the longfin squid fishery and (5) development of a data logger to assess tow duration in the bottom trawl fishery. All projects were successfully completed and reports are available at http://www.nefsc.noaa.gov/read/protspp/PR_gear_research/. Additionally, a contract to assess the scallop catch rates between a modified Turtle-excluder dredge design and the standard dredge design was completed and the report is available at the same website.

In addition, the NEFSC was involved in a study that used video cameras and turtle carcasses as a proxy for live sea turtles to ascertain the effectiveness of a modified scallop dredge to cause turtles to go over the dredge as opposed to under the dredge (where they are likely to be injured). The field component of this project was successfully completed in 2008, and the associated manuscript was prepared in 2009. Nine turtle carcasses went over the dredge and none went under the dredge. In 2009 the NEFSC supported work with ROVs to ascertain sea turtle behavior is areas frequented by scallop dredge fishing activities. Many hours of video were attained that yielded some new information on sub-adult sea turtle behaviors. Also in 2009, two turtles were tagged with satellite tags that record both pressure (depth) and location. These tags continue to transmit information after over six months.

NEFSC undertook several bycatch analysis projects. In one project, we estimated the magnitude of loggerhead bycatch in US mid-Atlantic gillnet gear and characterized bycatch patterns to identify areas where bycatch reduction can potentially be achieved. In another, we used observed interactions between sea turtles and commercial bottom trawling vessels to evaluate the conservation value of trawl gear modifications and to propose a new framework for evaluating bycatch mitigation alternatives. In addition, we are in the process of estimating loggerhead bycatch in Mid-Atlantic bottom trawl fisheries and scallop dredge fisheries.

h) Seabirds

The NEFSC has an in-press manuscript on the bycatch of common loons and red-throated loons in

Northeast and Mid-Atlantic gillnets that was based on observer data. The data sets to be used for bycatch of seabirds in bottom trawls were processed and will soon be ready to estimate seabird bycatch and explore environmental and fishing characteristics that are associated with high bycatch rates. NEFSC also conducted necropsies on bycaught seabirds that were recovered from observer fishing trips. During January 27-29, 2010, the NEFSC hosted the Northwest Atlantic Marine Bird Conservation Cooperative Workshop. On several of the NEFSC research surveys a visual observer conducted seabird and marine mammal strip transect surveys that will be used to estimate the relative density of these species. In addition, the NEFSC collaborated with other government, academic, and research organizations on planning upcoming seabird density surveys and on a proposal to fund additional seabird surveys, outreach to fishermen on seabird issues, and seabird bycatch mitigation research.

3. Studies of Fishing Operations

In 2009, NEFSC observers were deployed on 3,328 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 234 marine mammal incidental takes, 73 sea turtle incidental takes, and 249 seabird incidental takes. For most of these animals, take information was recorded including animal condition, length and other relevant body measurements, as well as species identification characteristics. A series of tissue samples were also collected from many of these animals and the entire animal was collected if possible.

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

In the sink anchored gillnet fishery, 755 trips were observed with a total of 2,944 gear retrievals. There were 144 observed marine mammal takes in this fishery (46 gray seals, 40 harbor porpoises, 26 harp seals, 21 harbor seals, eight unidentified seals, two common dolphins and one unidentified porpoise/dolphin). There were also 12 green, six loggerhead, five Kemp's ridley and two unidentified hard-shell turtle and 126 seabird takes observed in this fishery.

b) Float Drift Gillnet Fishery

There were 29 floating drift gillnet trips with 124 gear retrievals observed in 2009. There were no marine mammal, sea turtle or seabird takes observed.

c) Otter Trawl Fisheries

In the bottom otter trawl fishery 1,504 trips were observed with a total of 16,811 gear retrievals. In addition, there were 18 midwater trawl trips with 49 gear retrievals, 8 scallop trawl trips with 43 gear retrievals, 13 shrimp bottom otter trawl trips with 63 gear retrievals, three twin trawl trips with 39 gear retrievals, 11haddock separator trawl trips with 246 gear retrievals and one Ruhle trawl with 13 gear retrievales were observed in 2009. In the bottom otter trawl fishery, there were 85 observed marine mammal takes (35 Atlantic white-sided dolphins, 18 common dolphins, 10 gray seals, six unidentified pilot whales, five bottlenose dolphins, five harp seals, one unidentified dolphin, one Risso's dolphin, one unidentified porpoise/dolphin and one harbor seal). There were also 39 loggerhead turtle, two unidentified hard-shell turtle, one green turtle, one Kemp's ridley turtle, one leatherback turtle and 29 seabird takes in this fishery. In the mid-water trawl fishery there were no marine mammal, sea turtle or seabird takes observed. In the scallop trawl fishery there were no marine mammal, sea turtle or seabird takes observed. No marine mammal, sea turtle or seabird takes were observed in the shrimp bottom otter trawl fishery. There were no observed marine mammal, sea turtle or seabird takes on haddock separator trawl trips in 2009. One unidentified pilot whale was observed on the Ruhle trawl trip in 2009. No sea turtle or seabird takes were observed on the Ruhle trawl trip.

d) Sea Scallop Dredge Fishery

In the sea scallop dredge fishery, 504 trips were observed with a total of 38,070 gear retrievals. There were three loggerhead turtle and three seabird takes observed in this fishery.

e) Scottish Seine Fishery

No Scottish seine trips were observed in 2009.

f) Sink Drift Gillnet Fishery
In the sink drift gillnet fishery 116 trips were observed with a total of 658 gear retrievals. There were two harbor seals and 19 seabird takes in this fishery.

g) Anchored Floating Gillnet Fishery
There were six anchored floating gillnet trips with 14 gear retrievals observed in 2009. No marine mammal, sea turtle or seabird takes were observed in this fishery.

h) Mid-water Pair Trawl Fishery
In the mid-water pair trawl fishery 138 trips were observed with a total of 473 gear retrievals. One Atlantic white-sided dolphin, one harbor seal and 53 seabird takes were observed in this fishery.

i) Bottom Longline Fishery
In the bottom long line fishery 91 trips were observed with a total of 542 gear retrievals. There were seven seabird takes observed in this fishery. No marine mammal or sea turtle takes were observed in this fishery.

j) Beach Haul Seine Fishery
In the beach haul gillnet fishery 11 trips were observed with a total of 11 gear retrievals. There were two seabird takes observed in this fishery. No marine mammal or sea turtle takes were observed.

k) Pound Net Fishery
No pound net trips were observed in 2009.

l) Handline Fishery
There were four handline trips observed with 22 gear retrievals in 2009. No trolling trips were observed in 2009. No marine mammal, sea turtle or seabird takes were observed in these fisheries.

m) Herring Purse Seine Fishery
There were 53 herring purse seine trips with 134 gear retrievals observed in 2009. There were nine seabird takes observed in this fishery. No marine mammal or sea turtle takes were observed in this fishery.

n) Menhaden Purse Seine Fishery
There were 11 menhaden purse seine trips with 42 gear retrievals observed in 2009. One loggerhead turtle take was observed in this fishery. No marine mammal or seabird takes were observed.

o) Lobster Pot Fishery
No lobster pot trips were observed in 2009.

p) Fish Pot Fishery
There were 12 hagfish pot trips with a total of 180 gear retrievals and four scup trips with 14 gear retrievals observed in 2009. No marine mammal, sea turtle or seabird takes were observed in this fishery.

q) Conch Pot Fishery
No conch pot trips were observed in 2009.

r) Red Crab Pot Fishery
No red crab pot trips were observed in 2009.

s) Clam Dredge Fishery
No clam dredge trips were observed in 2009.

t) Scallop Beam Trawl Fishery
No scallop beam trawl trips were observed in 2009.

4. Population Dynamics Research

a) Atlantic Salmon Research

Atlantic salmon populations in eastern Maine have been formally listed as endangered under the United States Endangered Species Act. 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 agency and private partners, are designed to better understand the factors contributing to these declines. Research activities include a variety of field projects in natal rivers, in estuaries, and at sea. These data are used extensively in support of ICES stock assessment activities and the North Atlantic Salmon Conservation Organization management activities.

Field research in 2009 focused on obtaining smolt production estimates, marine telemetry, and monitoring of fishery removals on the high seas. Smolt production in various rivers is monitored through the use of in-river traps. Trapping programs either generate population estimates via mark-recapture techniques or provide qualitative estimates via index monitoring. A large hatchery smolt tagging program has provided information useful in characterizing smolt emigration and adult returns in relation to stocking practices. Results from these studies indicate differential migration success in relation to stocking location and time and have influenced resource management. 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) and evaluation of different hatchery products is 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 this fishery. All of these studies will contribute to recommendations for additional measures to be considered to halt the decline and restore the resource.

b) Cooperative Research

In FY 2009, the NEFSC Northeast Cooperative Research Program (NCRP) received supplemental funding for the purposes of filling data gaps through survey work, supporting the transition to sector management in Northeast groundfish fisheries, and assisting industry during the development of Amendment 16 to the Northeast Multispecies Fishery Management Plan.

With this additional funding, the NCRP supported external competitive programs through the Southern New England Cooperative Research Institute and the Northeast Consortium which focused on conservation engineering studies to reduce bycatch and technology transfer to the industry. In addition, the NCRP published a Broad Agency Announcement (BAA) requesting research proposals on topics such as fishery independent fixed gear surveys to assist in filling data gaps, enhanced stock monitoring supporting the management transition to Allowable Catch Limits and sectors, and expanded conservation engineering studies with an emphasis on by-catch reduction and industry assistance in adopting new technology. Examples of fishing gears to undergo expanded testing include the Southern New England drop chain, raised footrope trawls in small mesh fisheries, and modifications of sorting grids, escape panels, and topless net designs. The BAA competition resulted in the selection of eight cooperative research projects involving more than a dozen partners.

The supplemental funds also allowed the NCRP to develop and support cooperative trawl sweep comparison studies to evaluate the catchability of flatfish including winter, summer and yellowtail flounder using rockhopper and cookie sweeps on twin trawl and paired trawl vessels. These studies are being conducted on Georges Bank, the Gulf of Maine, and Southern New England waters through 2010, and will compare catch rates and size composition across habitat types and inform discussions on the need for a dedicated flatfish survey in the future. In 2009, the cooperative sweep comparison studies consisted of 26 vessel sea days and 210 NEFSC staff sea days.

During 2009, the collaborative monkfish survey was completed with 106 vessel sea days and 530 NEFSC staff sea days. Objectives of the survey included characterization of the size, age and sex composition and

geographic distribution of the monkfish population, and special studies including tagging, reproductive biology, genetics, otolith microconstituents, isotope analysis of diet and distribution with respect to temperature. Results of the industry-based monkfish survey will also be compared with results from the new NEFSC survey vessel FSV Bigelow.

Cooperative Research continues to support and grow the Electronic Logbook/Study Fleet Program, which focuses on using electronic reporting mechanisms for recording haul-based data as well as temperature and depth profiles, and provides direct assistance to industry partners. This program currently has more than 20 vessels operating in the groundfish, squid, and SNE yellowtail fisheries, and continues to solicit additional vessel for the program.

The NCRP also continued to provide funding for the Environmental Monitors on Lobster Traps, or eMOLT program in 2009. This partnership, involving NOAA, the State of Maine, the Commonwealth of Massachusetts, the Downeast and Atlantic Offshore Lobstermen's Associations, the Gulf of Maine Lobster Foundation, and the Marine Science Department at Southern Maine Community College (SMCC) in Portland, Maine, facilitates environmental monitoring using temperature probes on lobster pots and trawls. The project continues to collect hourly bottom temperatures from nearly 100 fixed locations around the Gulf of Maine and the Southern New England Shelf. For more information and data access, visit: http://emolt.org.

2009 Research Set-Aside (RSA) competitions were held for Scallops, Monkfish, and Mid-Atlantic Multispecies, and a programmatic review of all RSAs was completed. Efforts to improve the efficiency, conduct, and utility of the RSA programs continue in conjunction with the New England and Mid-Atlantic Fishery Management Councils.

In FY 2009, the NCRP also completed a strategic planning process that included several stakeholder meetings and coordination with a regional team comprising deputies from the NEFSC, Northeast Regional Office, New England Fisheries Management Council, Mid-Atlantic Fisheries Management Council, and Atlantic States Marine Fisheries Commission. This process resulted in several mandates which were approved by the Northeast Regional Coordinating Committee and included:

1. More creative use of acquisitions methods including grants, cooperative agreements, contracts, the NOAA Cooperative Institute for the North Atlantic Region, the Cooperative Ecosystems Studies Unit, the Northeast Consortium, and the Commercial Fisheries Research Foundation;
2. Exploring broader programmatic review and permitting processes for regulatory compliance with the Sustainable Fisheries Division, Protected Resources Division, and the National Environmental Policy Act; and
3. Encouraging a more networked organization of cooperative research activities in the Northeast.

Ongoing implementation of each of these directives began in late 2009, with activities to foster and develop a more cohesive, networked approach to Cooperative Research in the Northeast planned for early 2010.

c) 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. This provides some indication of the robustness of conclusions regarding stock status. 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. Work on the package continues to incorporate more modules, to test software for reliability, and to make the NFT more user-friendly. In 2009 the NFT website was updated and restructured, a number of new models were added, including depletion-corrected average catch (DCAC) and productivity and susceptibility analysis

(PSA), and many of the previously available models had their interfaces updated to increase functionality. The complete package may be accessed at http://nft.nefsc.noaa.gov/ (note that a password is no longer required).

d) Bigelow-Albatross Calibration

At 636 stations, standardized tows were made by both the R/V *Albatross IV* and FSV *Henry B. Bigelow* in 2008. These tows span both the traditional spring and fall survey seasons as well as some site-specific tows made during June or July. These data were analyzed and estimates of relative efficiency of the *Henry B. Bigelow* to the *Albatross IV* in terms of numbers and biomass were made based on various models. A panel of independent scientists reviewed analyses of these data in 11-14 August 2009, They made recommendations about which models to use to estimate relative efficiecy in terms of numbers for particular species. Ultimately, simple ratio estimators and estimators based on beta-binomial models the panel recommended depending on certain criteria. They advised accounting for differences with length in the estimation, but they also advised against using any estimates based on few data. The estimates of numbers-based relative efficiency are based on the panel recommendations and the biomass-based relative efficiencies are also based on additional estimates of relative efficiency for weight per fish (available in: Miller TJ, Das C, Politis PJ, Miller AS, Lucey SM, Legault CM, Brown RW, Rago PJ (eds). 2010. Estimation of Albatross IV to Henry B. Bigelow calibration factors. Northeast Fish Sci Cent Ref Doc. 10-05; 233 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://www.nefsc.noaa.gov/nefsc/publications/ .)

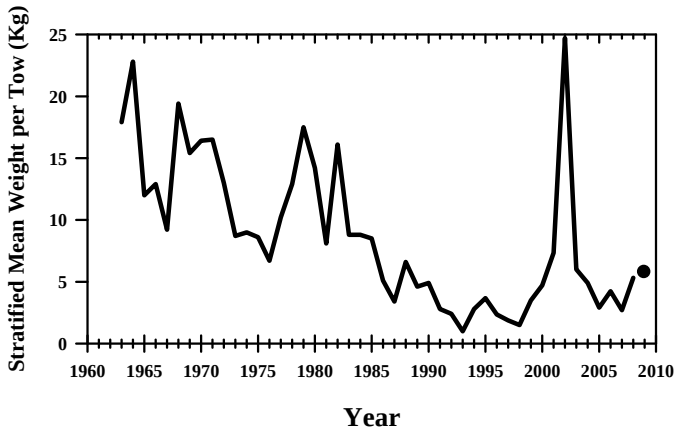

Figure 1. NEFSC autumn bottom trawl survey biomass indices for Gulf of Maine cod.

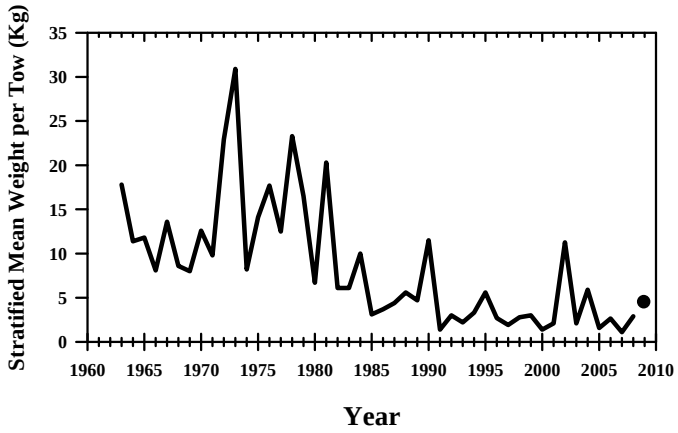

Figure 2. NEFSC autumn bottom trawl survey biomass indices for Georges Bank cod.

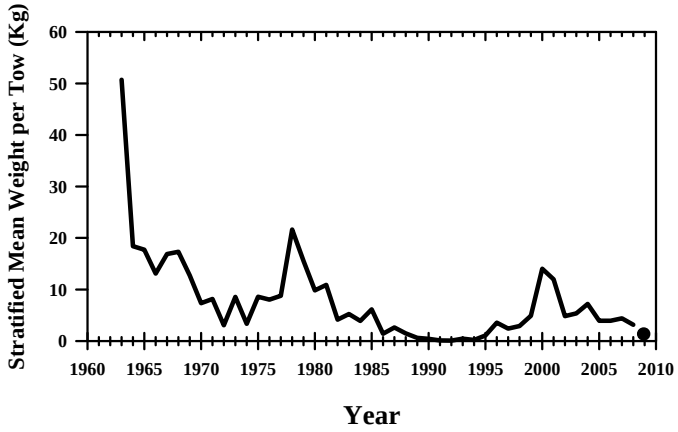

Figure 3. NEFSC autumn bottom trawl survey biomass indices for Gulf of Maine haddock.

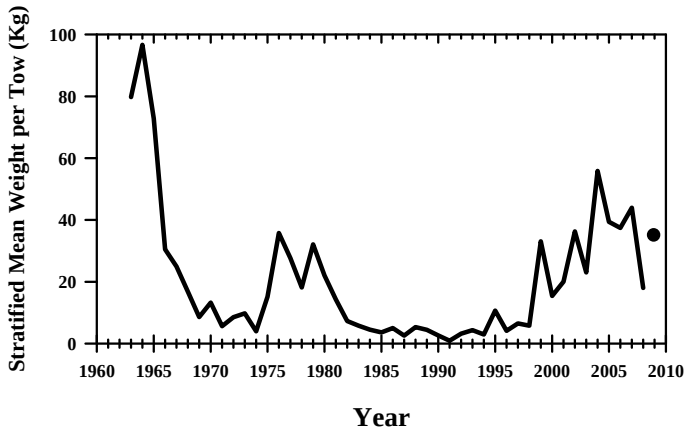

Figure 4. NEFSC autumn bottom trawl survey biomass indices for Georges Bank haddock.

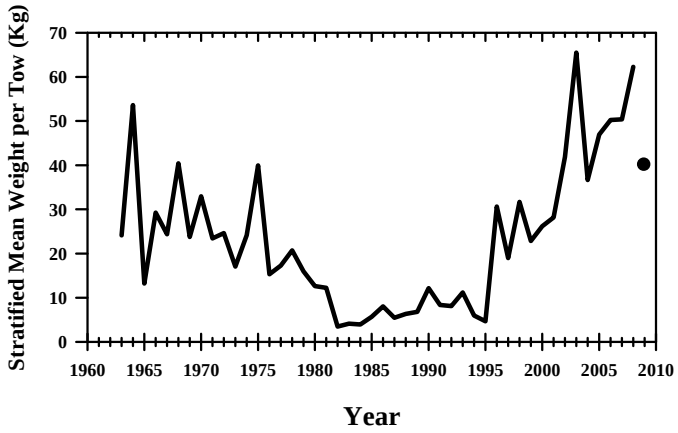

Figure 5. NEFSC autumn bottom trawl survey biomass indices for redfish.

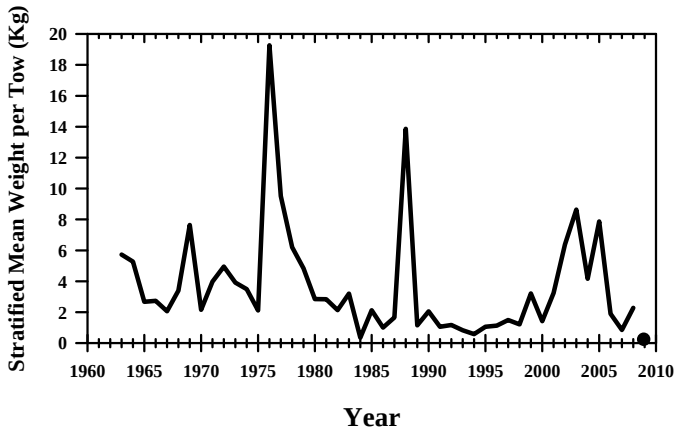

Figure 6. NEFSC autumn bottom trawl survey biomass indices for pollock.

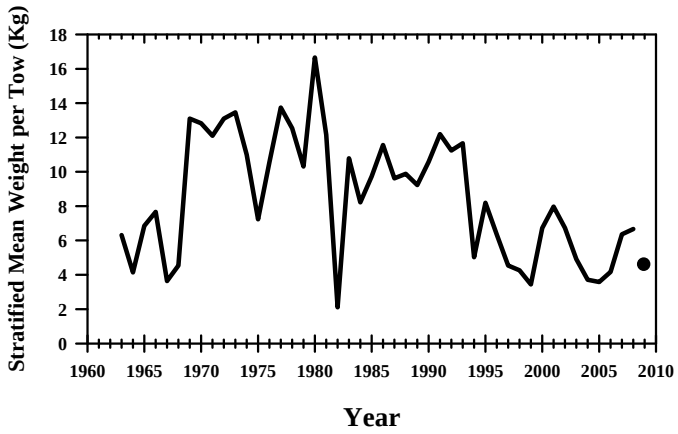

Figure 7. NEFSC autumn bottom trawl survey biomass indices for white hake.

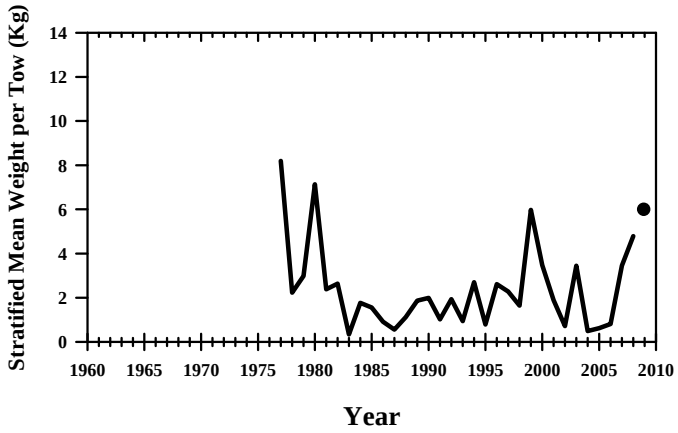

Figure 8. NEFSC autumn bottom trawl survey biomass indices for Cape Cod-Gulf of Maine yellowtail flounder.

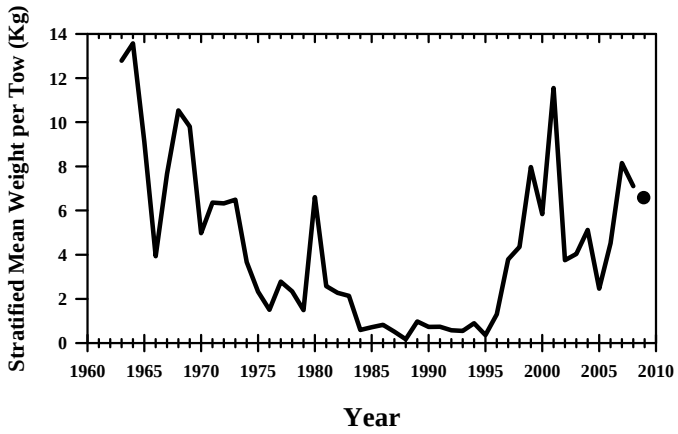

Figure 9. NEFSC autumn bottom trawl survey biomass indices for Georges Bank yellowtail flounder.

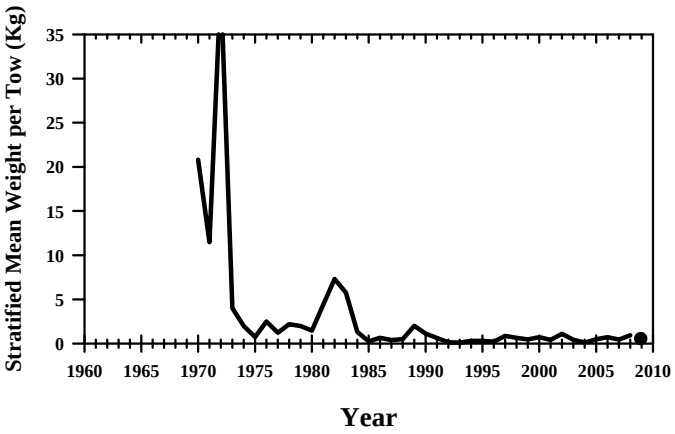

Figure 10. NEFSC autumn bottom trawl survey biomass indices for Southern New England-Mid-Atlantic yellowtail flounder.

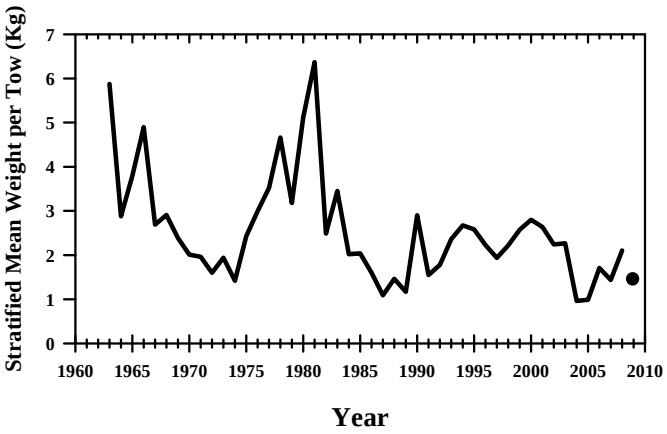

Figure 11. NEFSC autumn bottom trawl survey biomass indices for American plaice.

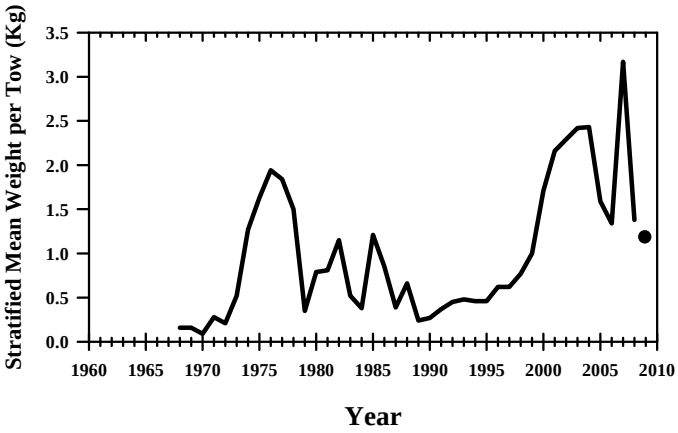

Figure 12. NEFSC spring bottom trawl survey biomass indices for summer flounder.

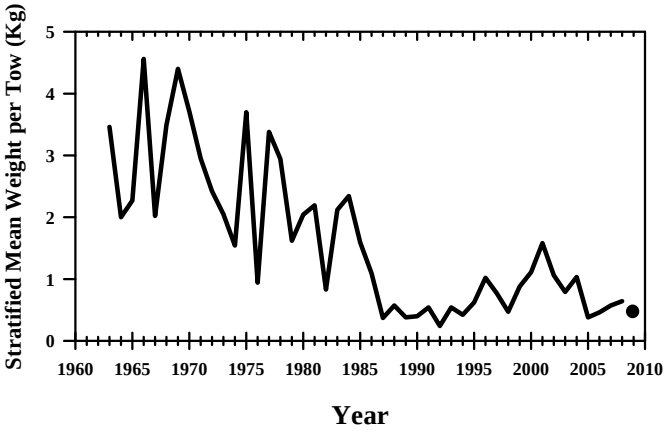

Figure 13. NEFSC autumn bottom trawl survey biomass indices for witch flounder.

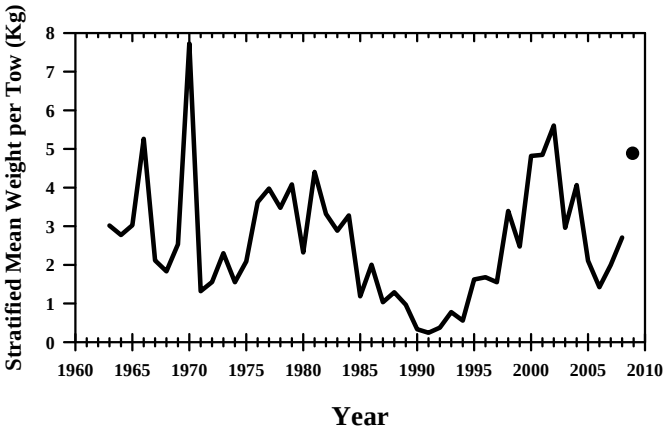

Figure 14. NEFSC autumn bottom trawl survey biomass indices for Georges Bank winter flounder.

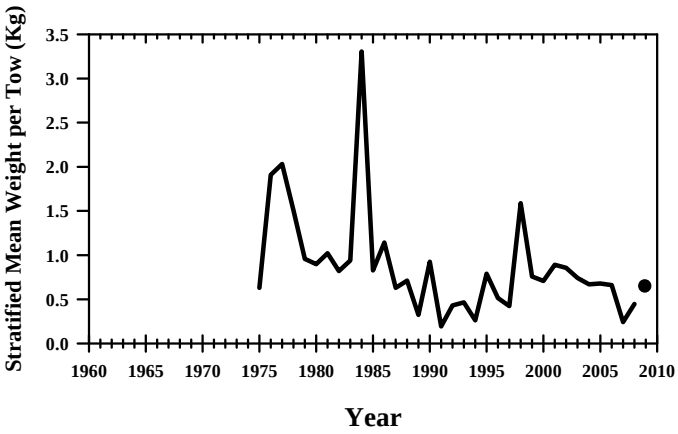

Figure 15. NEFSC autumn bottom trawl survey biomass indices for northern windowpane flounder.

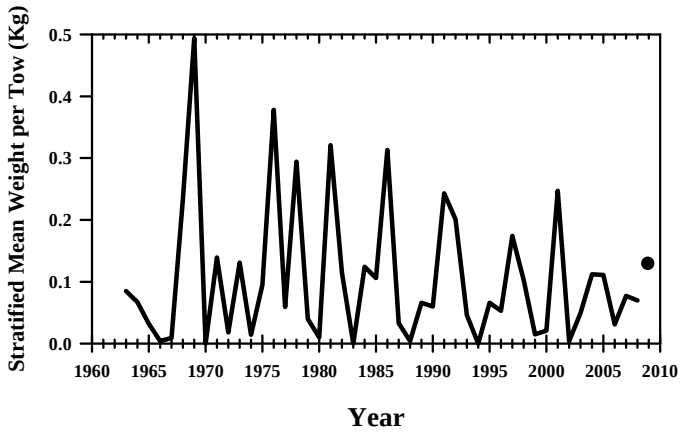

Figure 16. NEFSC autumn bottom trawl survey biomass indices for Atlantic halibut.

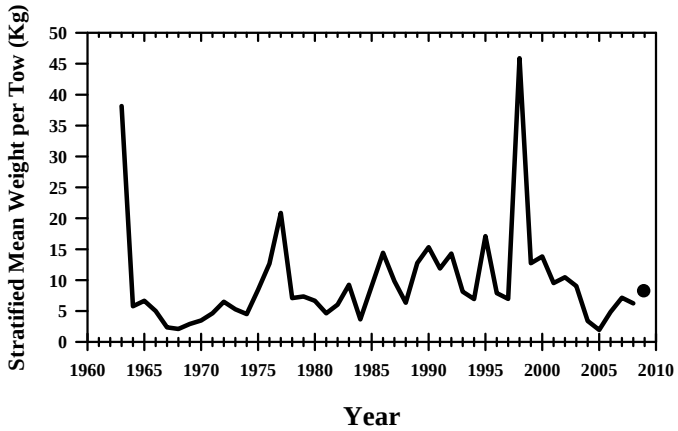

Figure 17. NEFSC autumn bottom trawl survey biomass indices for northern silver hake.

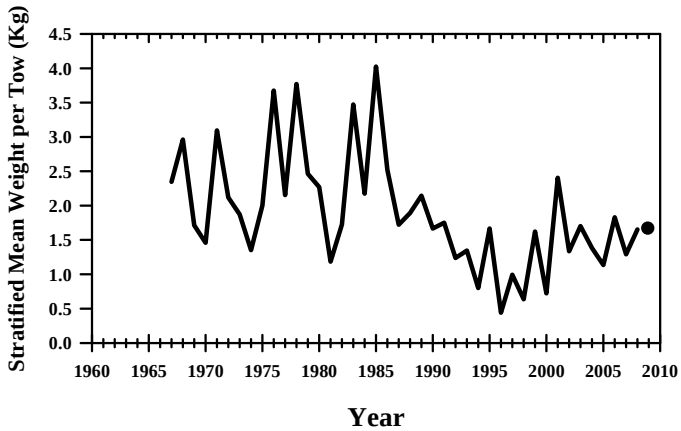

Figure 18. NEFSC autumn bottom trawl survey biomass indices for southern silver hake.

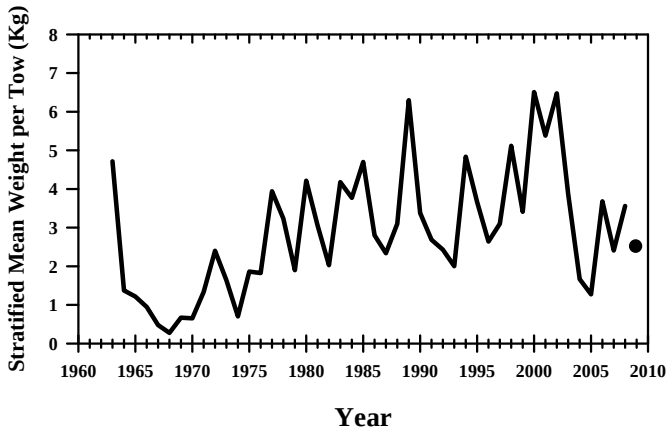

Figure 19. NEFSC autumn bottom trawl survey biomass indices for northern red hake.

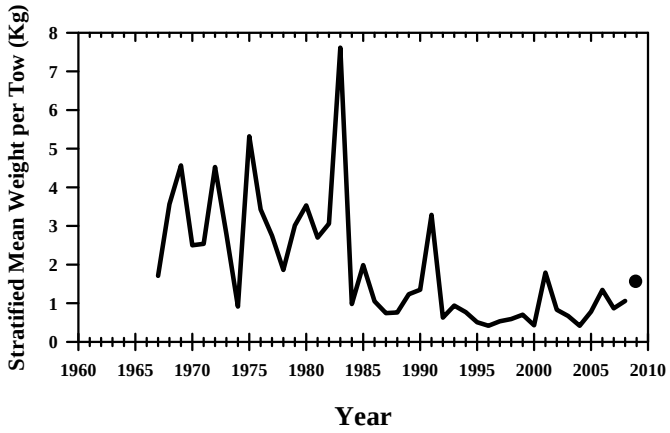

Figure 20. NEFSC autumn bottom trawl survey biomass indices for southern red hake.

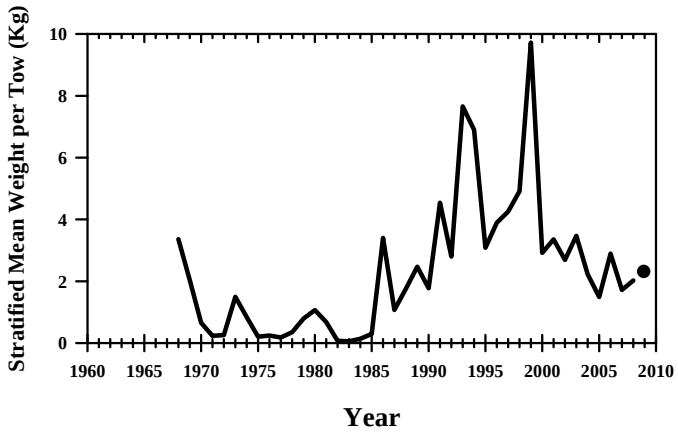

Figure 21. NEFSC spring bottom trawl survey biomass indices for Atlantic herring.

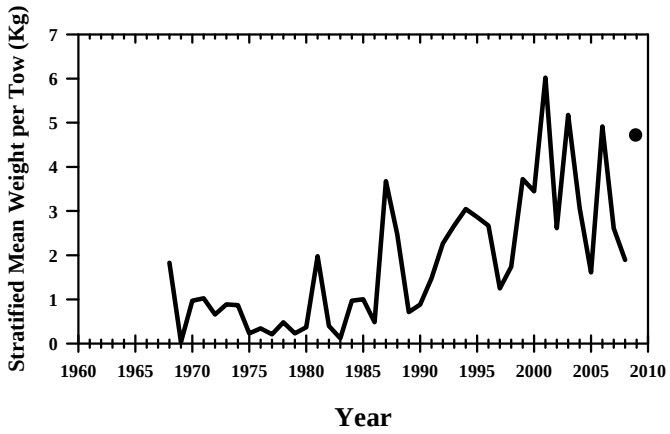

Figure 22. NEFSC spring bottom trawl survey biomass indices for Atlantic mackerel.

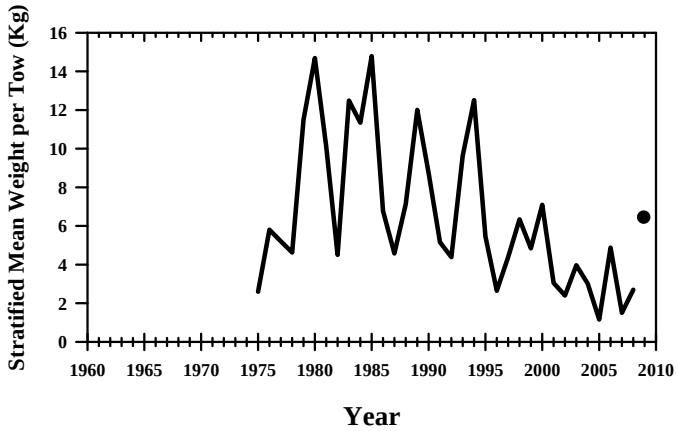

Figure 23. NEFSC autumn bottom trawl survey biomass indices for butterfish.

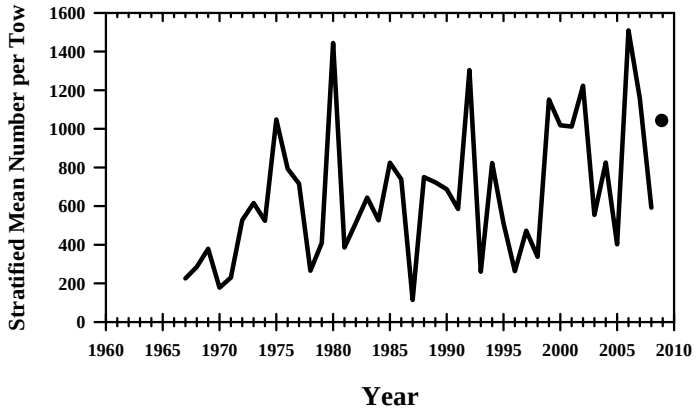

Figure 24. NEFSC autumn bottom trawl survey abundance indices for longfin inshore squid.

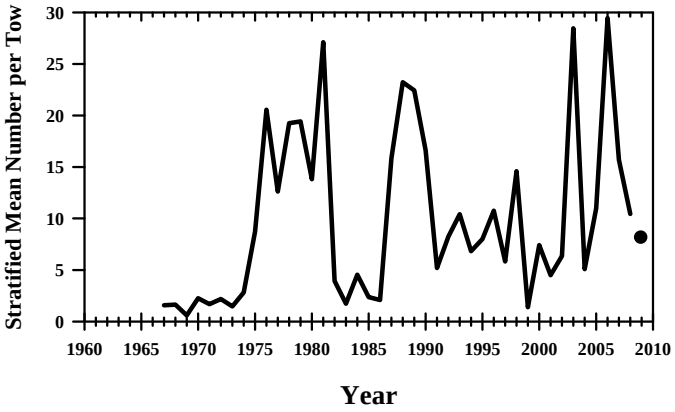

Figure 25. NEFSC autumn bottom trawl survey abundance indices for northern shortfin squid.

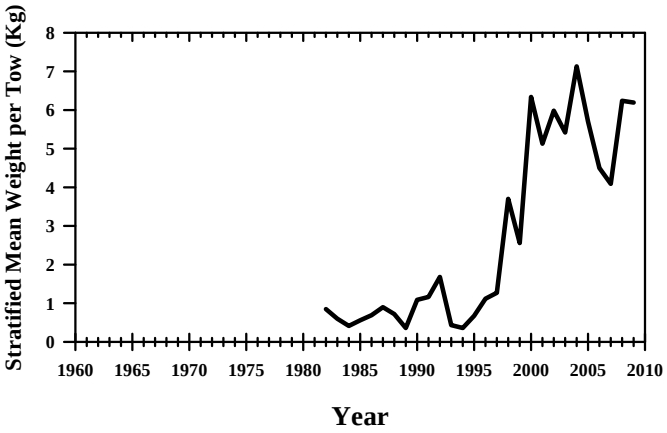

Figure 26. NEFSC scallop survey biomass indices for Georges Bank sea scallops.

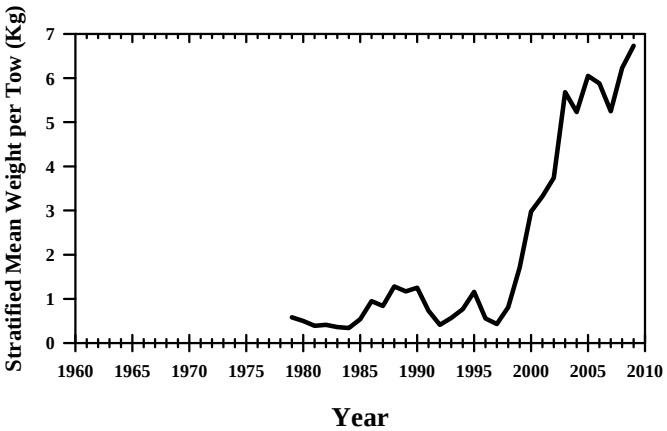

Figure 27. NEFSC scallop survey biomass indices for Mid-Atlantic Bight sea scallops.

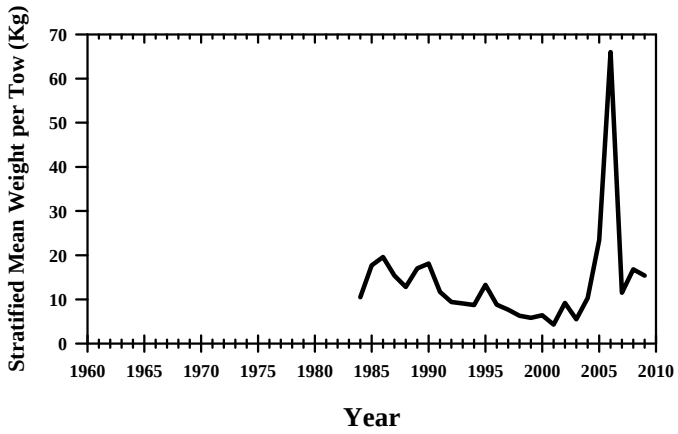

Figure 28. ASMFC summer shrimp survey biomass indices for northern shrimp.

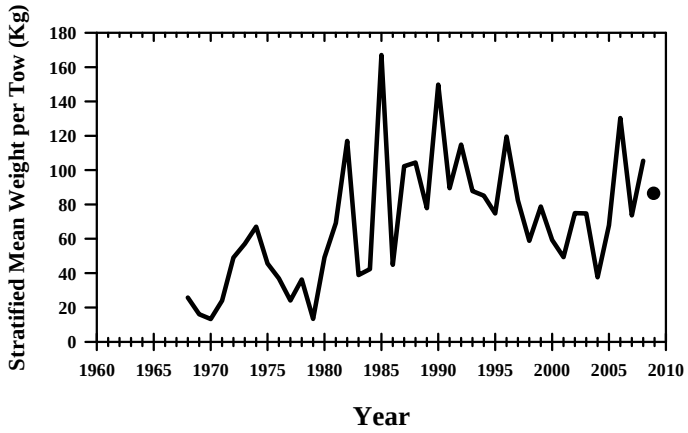

Figure 29. NEFSC spring survey biomass indices for spiny dogfish.

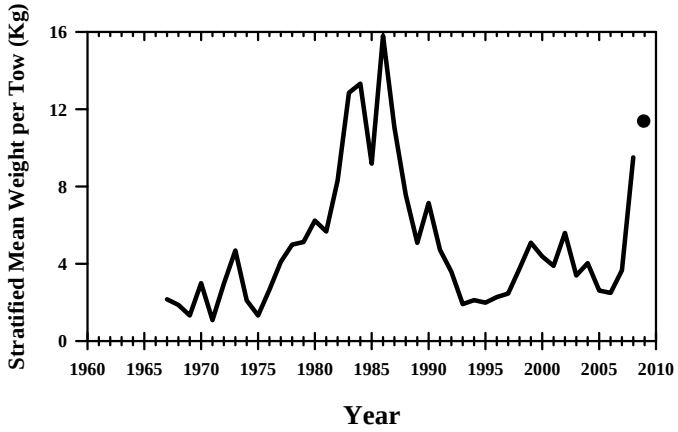

Figure 30. NEFSC autumn survey biomass indices for winter skate.

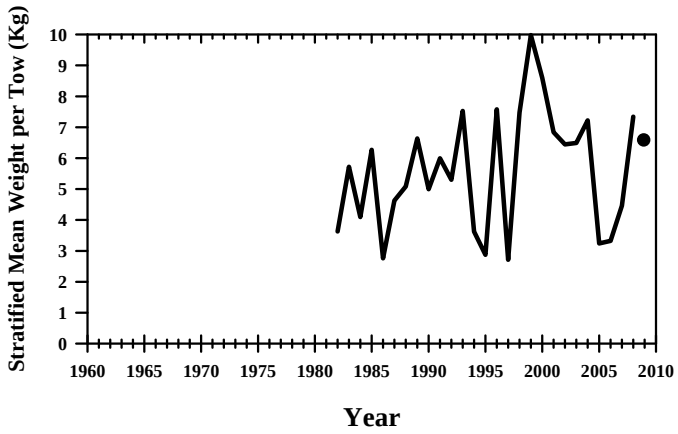

Figure 31. NEFSC spring survey biomass indices for little skate.

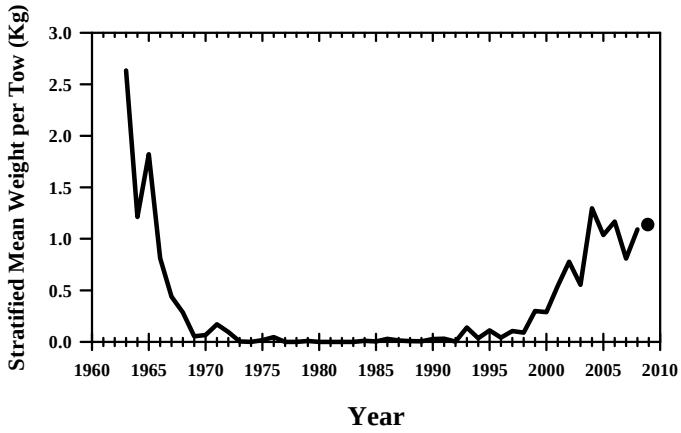

Figure 32. NEFSC autumn survey biomass indices for barndoor skate.

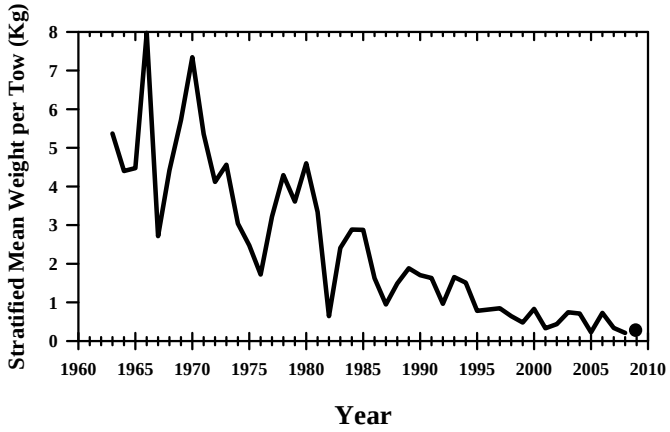

Figure 33. NEFSC autumn survey biomass indices for thorny skate.

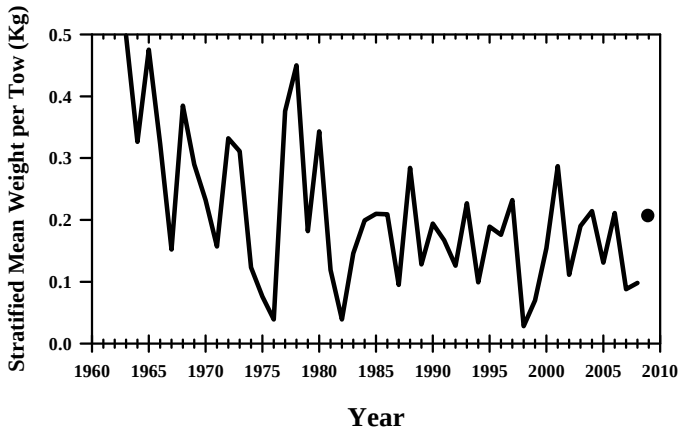

Figure 34. NEFSC autumn survey biomass indices for smooth skate.

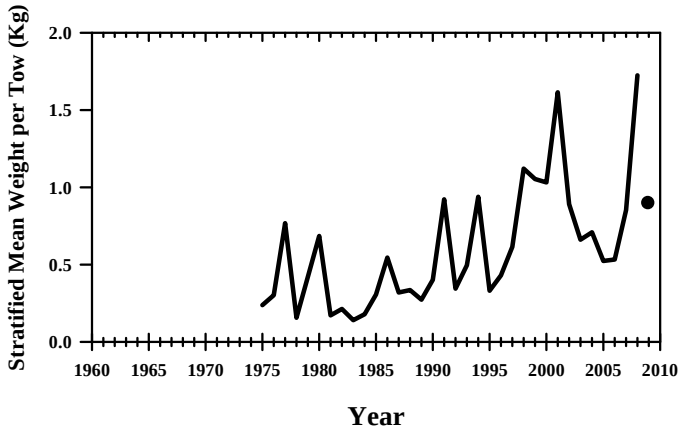

Figure 35. NEFSC autumn survey biomass indices for clearnose skate.

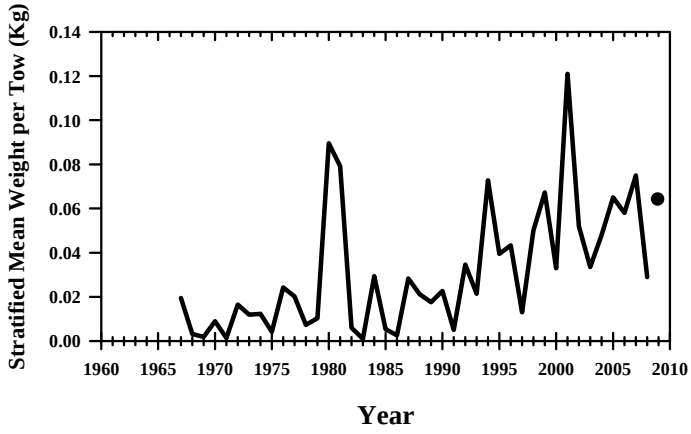

Figure 36. NEFSC autumn survey biomass indices for rosette skate.