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United States Research Report for 2014

by

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

Revised sampling and protocols were implemented in the Northeast Region in 1994, in 2004, and in 2010. 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.

Most spring and autumn survey indices for 2009-2014 were converted from the FSV *Henry B. Bigelow* catches (weights) to RV *Albatross IV* catches (weights) using either a single conversion factor or length-specific conversion factors which have only been estimated for some species. Consequently, 2009-2014 survey data points should be interpreted cautiously, and these values may change in the future as new methodologies are considered. The 2009-2014 data points have been plotted separately in the figures presenting spring and fall survey data. In 2014, the spring survey did not cover a large portion of the Mid-Atlantic region, and this has impacted the survey indices for summer flounder, southern red hake, Atlantic mackerel, Atlantic herring, spiny dogfish and little skate. The impact differs for each species and is discussed in those sections.

For the last few years, the United States has been allocated quota for Div. 3LNO yellowtail flounder and, from 2012-2014, a vessel fished in the area. An additional vessel fished in the area for Atlantic halibut in 2014. The sections for cod, haddock, yellowtail flounder, white hake, halibut, other flounders, and skates contain the landings and the discards of these species. The landings and discards of species not included below are summarized in Table 1.

1. Atlantic Cod

USA commercial landings of Atlantic cod (*Gadus morhua*) from Subareas 5&6 in 2014 were 2,346 mt, a 4% increase from the 2013 landings of 2,263 mt. In addition, 1.6 mt were landed from Div. 3N and 19.8 mt discarded. In Div. 3L, 0.7 mt were landed and less than 1 mt discarded. In Div. 3M and 3O there were 7.1 and < 1 mt discarded, respectively.

USA cod landings from the Gulf of Maine (Div. 5Y) in 2014 were 832 mt compared to 951 mt in 2013. Northeast Fisheries Science Center (NEFSC) research vessel survey biomass indices in the Gulf of Maine have been generally declining over the past five years (Figure 1). The 2014 biomass indices are some of the lowest of the time series. The stock continues to experience low recruitment.

USA cod landings from Georges Bank (Div. 5Z and SA 6) in 2014 were 1,514 mt compared to 1,312 mt in 2013. The NEFSC research vessel survey biomass indices for the Georges Bank

stock have been variable but declining in recent years and values for the last three years are among the lowest in the time series. Stock productivity remains poor with recent age 1recruitment well below the long term average.

2. Haddock

United States commercial landings of haddock (*Melanogrammus aeglefinus*) increased by a factor of 2.4 from 1,871 mt in 2013 to 4,554 mt in 2014. Landings for Georges Bank (Div. 5Z) haddock increased from 1,659 mt in 2013 to 4,240 mt in 2014. Gulf of Maine (Div. 5Y) haddock landings increased from 212 mt in 2013 to 314 mt in 2014.

The autumn research vessel survey biomass indices for the Gulf of Maine stock increased substantially in 2014 to 37.7 kg/tow relative to the 2013 estimate of 12.6 kg/tow (Figure 3). The recent increase in biomass is due to strong recruitment observed over the past three years. In the last decade, autumn survey biomass for Georges Bank haddock peaked at 55.8 kg/tow in 2004. Since 2004 large fluctuations have occurred in the survey index as year classes increased in weight. Mean biomass per tow was about 35 kg/tow in 2011 and 2012, and increased to 95 kg/tow in 2013, the second highest value in the time series, as the very large 2010 year class grew in length and weight. The biomass index in 2014 remained high at 97.8 (Figure 4).

3. Redfish

USA landings of Acadian redfish (*Sebastes fasciatus*) increased by 29% from 3,551 mt in 2013 to 4,576 mt in 2014. Fall research vessel survey biomass indices generally increased from 1996 through 2012 (Figure 5), with the 2010 and 2012 indices being the highest on record, before declining in 2013. Most recently, the survey biomass indices increased by 29% from 30.47 kg/tow in 2013 to 39.24 kg/tow in 2014.

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

USA landings of pollock (*Pollachius virens*) decreased from 5,058 mt in 2013 to 4,545 mt in 2014. Fall research vessel survey indices reflected a general increase in pollock biomass in Subarea 5 from the mid-1990s through 2005 (Figure 6). The survey biomass index has been variable since 2006, reaching a record-low of 0.22 kg/tow in 2009. Most recently, the index increased from 0.67 kg/tow in 2013 to 7.21 kg/tow in 2014.

5. White Hake

Nominal USA landings of white hake (*Urophycis tenuis*) from NAFO Subareas 5 and 6 decreased by 15.1% from 2,232 mt in 2013 to 1,894 mt in 2014. Landings from other NAFO areas include 7 mt in Div 3N and 5 mt in Div 3O. In Div. 3L, <0.1 mt was discarded, while 19 mt were discarded in Div. 3N and 0.9 mt discarded in Div. 3O. 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*) from NAFO subareas 5 and 6 were 1,006 mt in 2014, a 15% decrease from 2013 landings of 1,181 mt. In Div. 3N, landings decreased 15% from 900 mt in 2012 to 769 mt in 2013. Additionally, 55 mt of yellowtail flounder were discarded in Div. 3N bringing the total catch of yellowtail flounder in Div. 3N to 824 mt in 2014. Less than 1 mt of yellowtail flounder was landed in Div. 3O, with a smaller amount discarded in the same division.

USA yellowtail flounder landings from the Gulf of Maine (Div. 5Y) in 2014 were 421 mt compared to 590 mt in 2013. The NEFSC autumn research vessel survey biomass indices in the Gulf of Maine increased slightly over the last three years (Figure 8). In 2014, the NEFSC

autumn survey biomass was 2.95 kg/tow, a 38% decrease from the 2013 survey value of 4.80kg/tow (Figure 8).

USA yellowtail flounder landings from Georges Bank (Div. 5Z) in 2014 were 70 mt compared to 130 mt in 2013. The NEFSC autumn research vessel survey biomass indices on Georges Bank have been decreasing over the last five years (Figure 1). In 2014, the NEFSC autumn survey biomass increased slightly but was still among some of the lowest of the time series. The 2014 autumn survey was approximately 1.02 kg/tow compared to 0.88 kg/tow in 2013(Figure 9).

USA yellowtail flounder landings from the Southern New England-Mid Atlantic stock (SA 6) in 2014 were 551 mt compared to 461 mt in 2013. The NEFSC autumn research vessel survey biomass indices for the Southern New England-Mid Atlantic continue their decline since 2012 (Figure 1). In 2014, the NEFSC autumn survey biomass is among some of the lowest of the time series, estimated at 0.122kg/tow, approximately a third of the 2013 survey estimate of 0.43 kg/tow (Figure 10).

7. Other Flounders

USA commercial landings of flounders (other than yellowtail flounder and Atlantic halibut) from Subareas 3-6 in 2014 totaled 8,940 mt, 15% lower than in 2013. Summer flounder (*Paralichthys dentatus*; 56%), winter flounder (*Pseudopleuronectes americanus*; 22% comprising the Georges Bank, Southern New England, and Gulf of Maine stocks), American plaice (*Hippoglossoides platessoides*; 15%), witch flounder (*Glyptocephalus cynoglossus*; 7%), and windowpane flounder (*Scophthalmus aquosus*; <1% comprising the Northern and Southern stocks) accounted for virtually all of the 'other flounder' landings in 2014. Compared to 2013, commercial landings in 2014 were lower for windowpane flounder (-37%), winter flounder (-28%), witch flounder (-17%), summer flounder (-11%), and American plaice (-6%). The American plaice landings from Div. 3N were 97.5 mt. In addition, 40.7 mt of American plaice were discarded in Div. 3N bringing the total catch of American plaice in Div. 3N in 2014 to 138 mt.

Research vessel survey indices in 2014 remained similar to the previous year's indices for southern windowpane flounder, increased for American plaice, summer flounder, and witch flounder, but decreased for Georges Bank winter flounder and northern windowpane flounder (Figures 11-16).

8. Atlantic halibut

USA landings of Atlantic halibut (*Hippoglossus hippoglossus*) in the Gulf of Maine-Georges Bank region increased 29% from 34.7 mt in 2013 to 45 mt in 2014. In addition, 80.1 mt of halibut were landed in NAFO Subarea3 and 1.2 mt of halibut were discarded. Research vessel survey indices have little trend and high interannual variability due to the low capture rate of Atlantic halibut (Figure 17). In some years there are no Atlantic halibut caught, indicating that abundance is close to being below the detectability level of the survey. Indices for 2009 – 2014 were converted from FSV *Henry .B. Bigelow* units to RV *Albatross IV* units using the mean calibration coefficient of other flounders.

9. Silver hake

USA landings of silver hake (*Merluccius bilinearis*) from NAFO subareas 5 and 6 were 7,252 mt in 2014, a 17% decrease from 2013 landings of 6,184 mt.

USA silver hake landings in the north (Div. 5Y) in 2014 were 2,549 mt compared to 1,372 mt in 2013. The NEFSC autumn research vessel survey biomass indices for northern Silver hake have been steadily increasing over the last five years. In 2014, the NEFSC autumn survey

biomass was 18.77 kg/tow, a 12% increase from the 2013 survey value of 16.75kg/tow (Figure 18).

USA silver hake landings in the south (SA 6) in 2014 were 4,703 mt compared to 4,812 mt in 2013. The NEFSC autumn research vessel survey biomass indices for southern Silver hake have been relatively stable over the last five years. In 2014, the NEFSC autumn survey biomass was 1.44 kg/tow, an 8% increase from the 2013 survey value of 1.33 kg/tow (Figure 19).

10. Red Hake

USA landings of red hake (*Urophycis chuss*) increased from 517 mt in 2013 to 617 mt in 2014. Research vessel survey biomass indices for the Gulf of Maine - Northern Georges Bank stock increased after the early 1970s, markedly declined in 2003, and have since stabilized (Figure 20), though still low (3.02 kg/tow in 2014). Indices for the Southern Georges Bank - Mid-Atlantic stock declined in the 1990s and remained low in the 2000s, but increased again in 2009 through 2012. There was a small decline in 2013 (0.64 kg/tow, Figure 21), but increased slightly in 2014 to 0.73 kg/tow.

11. Atlantic Herring

Nominal preliminary USA landings of Atlantic herring (*Clupea harengus*) have been stable, equaling 95,191 mt in 2013 and 93,168 mt in 2014. Spring survey indices were relatively stable during 2007-2014 and averaged 2.23 kg/tow (Figure 22). The 2014 spring survey index was 2.25 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. Time varying natural mortality was applied in the 2012 assessment and consequently the assessment had relatively no retrospective pattern when compared to previous assessments. Preliminary updates of the stock assessment model using data through 2014, however, suggest a reemergence of the retrospective pattern. Age composition data show a persistence of the 2008 cohort, which lends some confidence to conclusions about this cohort's size from the 2012 assessment.

12. Atlantic Mackerel

USA commercial landings of Atlantic mackerel (*Scomber scombrus*) increased 26% from 4,372 mt in 2013 to 5,906 mt in 2014. Recreational catches decreased 14% from 894 mt in 2013 to 773 mt in 2014. In the 2014 spring survey, the southernmost strata were not sampled due to delays in the survey. Accordingly, 1968-2013 abundance indices were re-estimated using an abbreviated set of offshore strata and compared to estimates based on the full offshore strata set historically used to estimate mackerel spring survey indices. This comparison indicated that the use of an abbreviated set of strata did not impact temporal trends in relative abundance or biomass. Consequently, the abbreviated set of offshore strata was used to derive relative abundance and biomass indices from 1968-2014 (Figure 23). Spring survey indices increased during the 1990s and averaged 8.5 kg/tow during the last ten years (2004-2013). The spring survey index decreased from 3.77 kg/tow in 2013 to 0.99 kg/tow in 2014. Estimated 2014 relative abundance and biomass indices were both lower than the time series medians of 21.50 mackerel-per-tow and 4.08 kg-per-tow.

13. Butterfish

USA landings of butterfish (*Peprilus triacanthus*) increased 186.2% from 1091 mt in 2013 to 3122 mt in 2014 due to the continued development of the directed fishery, which was re-established in 2013. Fall research vessel survey biomass indices have fluctuated substantially since the 1970s, but were generally highest in the late 1970s to early 1990s. Since 1995, annual values have typically been less than the long-term average (mean = 6.17 kg/tow). Biomass in 2014 was the tenth lowest in the time series (Figure 24).

14. Squids

During 1999-2010, landings of longfin inshore squid, *Doryteuthis (Amerigo) pealeii*, gradually declined from 19,173 mt to 6,913 mt, respectively, then increased again to 12,820 mt in 2012. During the current management regime of trimester-based quotas, landings averaged 10,505 mt during 2007-2013 and totaled 12,063 mt during 2014.

Fall survey relative abundance indices of longfin squid (derived using only daytime tows) declined from the third highest point in the time series during 2006 (1,778 squid/tow) to 339 squid/tow in 2011. During 2012-2014 relative abundance was above the median but declined from 1,371 squid per tow in 2012 to 744 squid per tow in 2014 (Figure 25).

During 2003-2013, USA landings of northern shortfin squid (*Illex illecebrosus*) averaged 13,810 mt and reached a peak of 26,097 mt in 2004. In recent years, landings declined substantially from 18,797 mt in 2011 to 3,792 mt in 2013. During 2014, landings increased to 8,772 mt.

Fall survey relative abundance indices of Northern shortfin squid attained a record-high in 2006 (29.5 squid/tow) then steadily declined to 4.7 squid/tow in 2013 and was well below the time series median. During 2014, relative abundance increased to 8.3 squid/tow and was slightly above the median (Figure 26).

15. Atlantic Sea Scallops

USA Atlantic sea scallop (*Placopecten magellanicus*) landings in 2014 were 15,342 mt (meats), the lowest since 2000. The 2014 landings were about 3000 mt meats less than 2013, but still well more than the long-term (1957-2013) mean. The ex-vessel value of the landings was $424 million, around $43 million less than in 2013 but also still much higher than the long-term mean. The relatively low landings reflect the weak 2007-2009 year classes in the Mid-Atlantic Bight and weak 2009-2010 year classes on Georges Bank. Landings are expected to increase considerably in 2015-2017. Two rotational closures in the Mid-Atlantic, implemented to protect the strong 2010 year class there, will reopen in 2015. In addition, the substantial 2011 and very large 2012 year class on Georges Bank should enter the fishery in 2016 and 2017, respectively, thereby inducing further increases in landings.

Stratified mean scallop dredge survey biomass indices increased modestly in both the Mid-Atlantic and Georges Bank in 2014 (Figures 27 and 28). Although the biomass indices have declined from their peaks in the last decade, they are still high by historical standards. Recruitment (2012 year class) on Georges Bank was very high; it is the largest year class in at least 14 years. The strong recruitment was mainly observed across the southern flank of Georges Bank and Nantucket Shoals. Recruitment in the Mid-Atlantic was about average, and was mainly concentrated in relatively shallow depths.

16. Northern Shrimp

The USA northern shrimp (*Pandalus borealis*) fishery was closed during 2014 due to a severe decline in stock status. The fishery had not been closed since 1978, when biomass indices were very low. TALs and commercial landings in USA waters of Subarea 5 had been declining since 2011, and only about half of the TAL for 2013 was landed. The average landings for 2010-2013 were 3,831 mt, and the highest annual landings of northern shrimp were 12,824 mt in 1969.

Summer shrimp survey biomass indices declined during 1985 through 2004 (Figure 29). A sharp increase occurred in 2006 reflecting an exceptionally strong 2004 year class. The 2006 survey may have been less reliable due to a reduced number of tows; however, a similarly high index was also observed in the 2006 NMFS autumn bottom trawl survey. Biomass indices fluctuated around a lower level during 2007-2010 (average 14.4 kg/tow), then

subsequently declined steadily to time series lows observed in 2012-2014 (2.5kg/tow, 1 kg/tow, 1.7 kg/tow, respectively). Recruitment indices also reached record lows in 2012 and 2013, and the 2013 stock assessment concluded the stock has collapsed. The 2014 recruitment index increased slightly but was still well below the median for the 31-year time series.

17. Small Elasmobranchs

USA landings of spiny dogfish (*Squalus acanthias*) increased 45% from 7,319 mt in 2013 to 10,647 mt in 2014. 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 30). The 2014 data point is plotted, although the comparability with previous years has not been evaluated. The area not covered by the survey generally has a large proportion of the spiny dogfish biomass.

USA landings of skates (most species are still landed as unclassified) increased 9% between 2013 and 2014 from 14,015 mt to 15,315 mt. The landings are sold as wings for human consumption and as bait for the lobster fishery. In addition, 5 mt of thorny skate were landed in NAFO Subarea 3 and 23.8 mt were discarded. An additional 13.5 mt of barndoor skate and 6.9 mt of skate were discarded in Subarea 3.

Survey biomass indices for winter skate (*Leucoraja ocellata*) peaked in the mid-1980s (Figure 31) 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, declined through 2013, but increased in 2014.

For little skate, the lack of coverage in the southern strata described above for spring 2014 was analyzed for the entire time series to show the difference between including and excluding these strata on the estimate of mean abundance. In general, little skate are more abundant in the northern strata. Thus relative abundance estimates (catch per tow) based on the northern strata only will be higher than estimates based on the entire strata set. Over the entire time series (1968-2013) the ratio of the time series without the southern strata to the full strata set is 1.091. To adjust the observed 2014 value for this average ratio, the 2014 value of 7.14 was divided by 1.091 yielding a value of 6.54. Even though the adjustment effect is relatively small, caution should be exercised when interpreting status using the value for 2014. Little skate (*Leucoraja erinacea*) survey indices have generally fluctuated without trend (Figure 32).

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 33). Thorny skate (*Amblyraja radiata*) survey indices have declined over the entire time series, and are currently near record lows (Figure 34). Survey indices for smooth skate (*Malacoraja senta*) are highly variable, but have been generally stable for the last 20 years (Figure 35). Indices for both clearnose skate (*Raja eglanteria*) and rosette skate (*Leucoraja garmani*) generally increased over the time series (Figures 36 and 37). The indices for clearnose skate declined between 2001 and 2006, but sharply increased in both 2007 and 2008.The indices have declined since 2011.

B. Special Research Studies

1. Environmental Studies

a) Hydrographic Studies

A total of 1211 CTD (conductivity, temperature, depth) profiles were collected and processed by the Northeast Fisheries Science Center (NEFSC) in 2014 over the course of 8

cruises. Of this total, 1201 CTD profiles were obtained within 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 bottom 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 2014 was similar to 2013, not as warm as 2012. These 14-year time series of hourly bottom temperatures at many locations are now being compared to multiple ocean models and, in some cases, being assimilated into hindcast runs. Plans are underway to transmit near-realtime data of both temperature and velocity from new instruments under development. More than 200 satellite-tracked surface drifters were deployed off the coast of New England in 2014, and dozens more are planned for 2015 (see http://www.nefsc.noaa.gov/drifter). The collective archive helps resolve the transport pathways of estuarine and shelf waters. The drifter project is promoted as an educational tool where students are involved with both the construction of the instruments and the processing, plotting, and analysis of the data.

b) Plankton Studies

During 2014, zooplankton community distribution and abundance were monitored using 497 bongo net tow samples taken on seven surveys. Each survey covered all or part of the continental shelf region from Cape Hatteras northeastward through the Gulf of Maine. These bongo net tows were supplemented by video imagery collected during the spring Atlantic Marine Assessment Program for Protected Species (AMAPPS) survey. The autumn monitoring / pelagic cruise was combined with acoustic midwater scanning at four different frequencies to locate concentrations of juvenile and adult small pelagic fish. Promising acoustic returns were "ground-truthed" with 24 midwater trawls to capture specimens of the fish seen in the acoustic signatures. This autumn ecosystem monitoring survey was a first in that it included an onboard respirometry experiment in collaboration with Rutgers University, where live fish from the midwater trawls had their oxygen consumption measured in a respirometry chamber set up in the vessel's wetlab. The autumn ecosystem monitoring survey also had an imaging flow-cytobot unit from the Woods Hole Oceanographic Institute installed in the scientific seawater flow-through system. This unit collected images of phytoplankton and marine ciliates from near-surface water pumped in from the bow of the vessel. Three of the seven cruises collected a total of 73 nutrient samples. This was done in collaboration with the University of Maine to monitor levels of nutrients in the euphotic zone. The two dedicated ecosystem monitoring surveys also collected 33 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, were for genetic analysis of the plankton samples, to supplement identifications made by traditional visual taxonomic means. These same two surveys also collected 112 additional plankton samples with a smaller bongo net for larval fish and egg sample genetics studies.

c) Benthic Studies

Wind Energy Benthic Habitat Investigation: Cruise time for wind energy-related benthic studies during 2014 was obtained by piggybacking on Atlantic Marine Assessment Program for Protected Species (AMAPPS) cruise legs aboard NOAA Ship *Gordon Gunter*: cruise GG-14-02 Leg I (March 07 – 31) and Leg II (April 03 – 27). Benthic sampling was performed in conjunction with a multi-year contract with the U.S. Department of Interior Bureau of Ocean Energy Management (BOEM) for a preliminary investigation of benthic/demersal habitats in designated wind energy lease areas (WEAs) off the coast of the northeast United States. Eight such areas have been designated by BOEM in association with adjacent states between Cape Cod, Massachusetts and Cape Hatteras, North Carolina (asterisks * indicate areas sampled during 2014):

- NAFO subdivision 5Zw: Massachusetts* (MA WEA), Rhode Island-Massachusetts* (RIMA WEA),
- NAFO division 6A: New York* (NY WEA), New Jersey* (NJ WEA),
- NAFO division 6B: Delaware (DE WEA), Maryland (MD WEA),
- NAFO division 6C: Virginia* (VA WEA), and North Carolina-Kitty Hawk (NC-KH).

All areas are located entirely on the continental shelf at depths ranging approximately 10-45 nautical miles (19-83 km) offshore in water depths of 15-60 m. The total area of these WEAs is about 2.6 million acres (≈10,500 km^2). The entire program will involve high resolution acoustic mapping of the bottom in all eight WEAs as well as characterization of oceanographic conditions, topography, sediments, and benthic biota, including infauna, epifauna, and demersal fishes. Acoustic mapping and underwater camera surveys of bottom have been performed before 2014, or will be performed subsequently, and a great deal of pre-existing data has been amassed for purposes of building benthic habitat profiles of the WEAs. Of particular interest are patches of hard substrate (gravel to boulders and rock outcrops) that may serve as shelter for shelter-seeking demersal fishes, e.g. black sea bass (*Centropristis striata*), scup (*Stenotomus chrysops*), and tautog (*Tautoga onitis*), and are potentially vulnerable to disturbance from construction or operational activities.

The 2014 AMAPPS cruise aboard *Gordon Gunter* was devoted to grab sampling for sediment grain size and benthic infaunal analysis and trawling with a 2 m beam trawl for epibenthic/demersal fauna in the MA, RIMA, NY, NJ, and VA WEAs. The MD WEA was sampled in 2013. A total of 70 grab samples was made in 2014 using a Young-modified Van Veen grab sampler and 62 trawl samples were taken with a 2 m beam trawl with a 0.25" (6.35 mm) mesh net towed at 2 kt (1 m/sec) for 5-20 minutes. CTD profiles were collected at each station. Visual surveys for protected species were conducted in the WEAs during the daytime and benthic sampling was performed at night or in inclement weather when visual surveys could not be performed. Beam trawl catches were identified on board the cruises and benthic infauna were preserved and identified by a consultant on shore following the cruise.

The overwhelming numerical dominant in most beam trawl catches in all WEAs sampled was the sand shrimp *Crangon septemspinosus*. While not fished or managed, this species is important as it is known to consume newly-settled juvenile fishes in substantial numbers and because it in turn serves as a major food source for larger demersal fishes. Juvenile fish catches (1-10 cm total length) were dominated by smallmouth flounder (*Etropus microstomus*), and red, spotted, and silver hakes (*Urophycis chuss, U. regia, Merluccius bilinearis*). Bottom sediments sampled on the cruise ranged from muddy sand to sandy gravel, but most were sand-dominated if not exclusively sand. Infaunal samples in all areas were heavily dominated by polychaete worms, amphipod crustaceans, and bivalve mollusks typical of the kinds of sandy bottoms found at nearly all stations.

Deep Sea Coral Investigations: Following up on the extensive mapping and visual surveys conducted on the continental margin in 2012-2013, further visual surveys were conducted on the continental slope and canyons on the southern margin of Georges Bank (NAFO subdivision 5Ze). These cruises were conducted using various underwater camera vehicles in search of deep sea coral habitats and their association with fishes primarily at depths exceeding 1000 m. Collaborations with U.S. and Canadian academic colleagues made available camera vehicles for this purpose. Habitat suitability models for major coral taxa were successfully employed as a guide to finding these habitats. Additional cruises were conducted in the western Gulf of Maine (NAFO division 5Y) that discovered new areas of deep sea coral habitat in the vicinities of the Schoodic Ridge and Mount Desert Island, with implications for their function as fish habitats.

2. Biological Studies

a) Fish Species

Flatfishes: 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, continue to implement experimental studies designed to evaluate the potential effects of future ocean conditions (elevated CO_2 and water temperature) on early life-stages of marine fishes. 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) wide yet realistic ranges of environmental conditions (e.g., concurrent manipulation of CO_2 levels and water temperatures), and iii) diverse, ecologically relevant response variables. The research team has grown by bringing in colleagues and collaborators with different skills with respect to the set of biotic response variables to be included in the analyses. To date, we have completed five experiments that evaluate the effects of high CO_2 seawater on the early life-stages of finfish important to the NW Atlantic. Two experiments have been conducted on summer flounder, *Paralichthys dentatus*, and three on winter flounder, *Pseudopleuronectes americanus*. The first experiment on summer flounder, a one-way experimental design with CO_2 levels as the factor (at 3 levels) is complete and published (Chambers et al. 2014. *Biogeosciences*, 11, 1613-1626, doi:10.5194/bg-11-1613-2014, 2014.). The other four experiments are all two-way designs (CO_2 × water temperature) and the post-experiment response variables are currently being analyzed. In all cases our focus was on early life-stages – embryos, larvae, and including effects on gametes in the later studies. The responses scored are viability, survival, developmental rate, growth rate, histological changes, otolith allometry, biochemical measures of fish condition, and differential gene expression. Our results from the summer flounder one-way design showed a significant negative affect of increased CO_2 on embryo survival and on larval growth and development. Larvae were initially larger, develop more quickly but metamorphose at smaller sizes at high CO_2 levels. Results from the 2-way experiments on both species show significant though opposite effects of CO_2 on fertilization rates with a negative impact of increasing CO_2 on fertilization in summer flounder but a positive one in winter flounder. Both species exhibited significant interactions in responses to CO_2, temperature, and parentage. In the coming year we will complete our analyses and implement follow-up work on two fronts: 1) the potential for transgenerational effects on the resilience of offspring to high CO_2, and 2) intraspecific, inter-population differences in resilience to high CO_2 between stocks that experience contrasting levels of environmental variance in CO_2 in situ. For the former study we will evaluate responses in three small-bodied forage species that can be housed and accommodated by our CO_2 delivery system. Those taxa are Atlantic silverside (*Menidia menidia*), mummichog (*Fundulus heteroclitus*), and Atlantic tomcod (*Microgadus tomcod*). Winter flounder is our experimental model for the inter-population contrasts where we will compare responses of offspring derived from parents collected inshore at two latitudes (New Jersey, New Hampshire) with those from an offshore spawning population (Banks offshore from Massachusetts).

Sturgeons: During 2014 we conducted multiple experiments on habitat constraints in shortnose and Atlantic sturgeons (*Acipenser brevirostrum* and *A. oxyrhynchus*, respectively) that built upon our earlier pilot eco-toxicological studies. Our earlier work evaluated the toxic responses of embryos and larvae after aqueous exposures to PCB 126 and TCDD (dioxin). Rates of uptake of radiolabelled PCB126 were also quantified. We measured 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 lethal and sublethal toxicities to both contaminants were expressed in both species in 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 (*Environmental Toxicology and Chemistry* 31:2324-2337). Our new work, funded for two years by the Hudson River Foundation, the NOAA National Ocean

Service Office, and the Delaware River Basin Commission (DRBC) is evaluating the separate and combined effects of toxins and climate change on early life-stages of both sturgeon species. The toxins to be used in 2014 were four congeners of PCBs (77, 81, 126, and 169), an Aroclor mixture, and dioxin. The thermal challenge exposed embryos to the entire thermal tolerance range of each species with up to 40 different constant temperatures which allowed us to clearly depict the functional form of phenotypic plasticity. In 2015 we will conduct 2-way designs (toxin × temperature) in order to evaluate the interactive effects of these co-stressors. The DRBC-funded component will explicitly evaluate the role of dissolved oxygen with thermal warming as a co-stressor in Atlantic sturgeon. We intend to evaluate our DO-delivery system and collect preliminary data on early life-stage responses of shortnose sturgeon.

b) Resource Survey Cruises

During 2014, 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. In aggregate, the survey staff efforts totaled 154 research and charter vessel sea days. NOAA scientific and contract staff involvement in the various cruises totaled of 1,508 person sea days, and volunteers contributed another 563 person sea days. ESB cruises occupied 1,044 stations in an area extending from Cape Hatteras, North Carolina to Nova Scotia. A total of 120,864 length measurements were recorded, representing 2,228,231 individuals from 275 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 2014 to fulfill special survey sampling requests from 60 NOAA and University investigators. This sampling included 13,848 feeding ecology observations, collection of 28,659 aging structures, and acquisition of 9,589 samples/specimens to support additional shore-based research.

c) Age and Growth (http://www.nefsc.noaa.gov/fbp/)

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 2014, the Program provided ages on nearly 75,000 otoliths and other hard structures from 19 species. The top species by numbers aged were: American plaice (9,445), haddock (8,346), Atlantic cod (5,459), Atlantic herring (5,172), yellowtail flounder (4,946), scup (4,929), summer flounder (4,917), and 4,653 black seabass. Other species worth mentioning are pollock, witch and winter flounder, silver and red hake, and redfish for which 23,075 specimens were aged. 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 2014, haddock, cod, and Atlantic herring age structures were exchanged with age readers from the St. Andrews Biological Station (Fisheries and Oceans Canada). Furthermore black sea bass, scup and summer flounder structures were exchanged amongst 8 laboratories from South

Carolina to Maine to maintain age determination comparability among laboratories, under the auspices of the Atlantic States Marine Fisheries Commission.
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 2014 included:

(1) Initiated sampling of windowpane with the Study Fleet Biosampling Program to develop a marginal increment analysis to validate age estimates;
(2) continued analysis to decipher population structure for cod using difference in growth patterns;
(3) continued partnership with Atlantic States Marine Fisheries Commission to create an aging manual that will standardize processing and aging for species of the Atlantic;
(4) continued a project on white hake life history, in partnership with the State of Maine;
(5) continued enhanced biological sampling of selected groundfishes to examine fecundity dynamics;
(6) continued calibration of macroscopic gonad staging performed during research vessel survey cruises as validated by an independent, gonad histology method;
(7) continued analysis of environmental effects on haddock growth and reproduction;
(8) continued to investigate the feasibility of measuring bioelectrical impedance (BIA) as a predictor of fish condition and reproductive potential;
(9) 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;
(10) completed manuscripts on:

- the reproductive biology of the American goosefish,
- stock- and year- specific fecundity of yellowtail flounder, and
- diagnosis of paired-age agreement.

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 2014, stomachs from 7,671 individuals and 47 species were examined in the spring, and stomachs from 7,707 individuals and 51 species were examined in the fall. Diet sampling emphasized gadiformes, elasmobranchs, small pelagics, flatfishes, and lesser known species.

The 42-year time series (1973-2014) 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 and over 160 predators. The processing of the 2014 bottom trawl survey food habits data is scheduled for completion in 2015.

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. In 2014, stomachs from juveniles (<=12 cm) of predators routinely examined at sea were preserved for laboratory processing.

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 continued in 2014 and provided 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 and presentations 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 climate, habitat and invasive species, fish interactions with gelatinous zooplankton, 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 2014. Information was received on 5,000 tagged and 600 recaptured fish bringing the total numbers tagged to 249,000 sharks of more than 50 species and 15,000 sharks recaptured of 33 species.

Staff participated in the SEDAR Data Workshop for the assessment of the Atlantic smooth dogfish population and the Gulf of Mexico smoothhound complex. A working paper for Atlantic smooth dogfish was presented during the workshop summarizing mark/recapture data from the Cooperative Shark Tagging Program (Kohler et al. 2014). In addition, five working papers detailing multiple indices of abundance for Atlantic smooth dogfish were developed using longline survey data from the Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) survey (McCandless 2014b), the South Carolina Department of Natural Resources (McCandless and Frazier 2014), and the University of North Carolina (McCandless et al. 2014d); as well as, gillnet survey data from the North Carolina Division of Marine Fisheries (McCandless et al 2014c) and gillnet observer data from the Northeast Fisheries Observer Program (McCandless and Mello 2014). Multiple indices of abundance were also developed for six working papers using trawl survey data from the University of Rhode Island (McCandless 2014c), Rhode Island Department of Environmental Management (McCandless and Olsewski 2014), Connecticut Department of Energy and Environmental Protection (McCandless and Gottschall 2014), New York State Department of Environmental Conservation (McCandless and Grahn 2014), New Jersey Division of Fish and Wildlife (McCandless et al. 2014b), and Delaware Division of Fish and Wildlife (McCandless and Greco 2014). Additionally, staff co-chaired the Indices Working Group for the SEDAR Data Workshop and produced Indices Working Group Reports summarizing working group recommendations for both the Atlantic smooth dogfish and smoothhound complex. Staff also developed a working paper for the SEDAR Assessment Workshop detailing the hierarchical analysis of the recommended indices of abundance to create a single index of abundance to use in sensitivity analyses during the SEDAR Assessment Workshop for both the Atlantic smooth dogfish and the Gulf of Mexico smoothhound complex (McCandless 2014a).

The COASTSPAN program 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 2014, 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. In 2014, data from these COASTSPAN surveys were provided to NMFS Highly Migratory Species Management Division for use in a 5-year review of Essential Fish Habitat designations for all managed shark species. Additionally, data from the COASTSPAN survey conducted in Delaware Bay were used to produce indices of abundance for Atlantic smooth dogfish that were presented in a working paper at the SEDAR Data Workshop in May 2014 (McCandless 2014b).

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. In 2014 staff attended 8 tournaments and examined 125 sharks.

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 3,600 sharks have been tagged and over 280 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.

A total of 150 spiny dogfish that were injected with oxytetracycline during the 2011-2012 tagging study have been returned to the APP for age validation, with 90 of these fish in good condition to obtain measurements for reproductive studies. A study continued on the seasonal cycle of female spiny dogfish reproduction with samples of mature females collected monthly starting in July for analysis of reproductive stage of the female and the embryos. This project will continue for a total of 24 months.

APP staff in cooperation with staff from Northeast Fisheries Science Center Cooperative Research, Greater Atlantic Regional Fisheries Office, Southeast Fisheries Science Center, Massachusetts Division of Marine Fisheries and the Florida Museum of Natural History published a study on white sharks in the Northwest Atlantic that provides an optimistic outlook for their recovery (Curtis et al. 2014). This study built upon previously published data combined with recent unpublished records to present a synthesis of 649 confirmed white shark records compiled over a 210-year period (1800-2010) and is the largest white shark dataset yet compiled for the Northwest Atlantic. Descriptive statistics and GIS analyses were used to quantify the seasonal distribution and habitat use of various subcomponents of the population. Relative indices of abundance from historical NEFSC surveys, NEFSC tournament data, the observer program for the directed shark longline fishery, and visual records of white sharks in New England waters were analyzed to determine temporal trends of white shark abundance in the Northwest Atlantic.

APP staff contributed to and led the Status Review Team for the Northwest Atlantic dusky shark in response to a positive 90-day finding indicating that petitions presented substantial information indicating that listing under the Endangered Species Act as threatened or endangered may be warranted for this population. APP staff conducted multiple analyses and summarized data from all available resources for use by the Status Review Team to conduct a comprehensive review and extinction risk analysis for the Northwest Atlantic dusky shark population. APP staff provided NMFS Office of Protected Resources with a Status Review Report (McCandless et al. 2014a) indicating that the Northwest Atlantic dusky

shark distinct population segment was at low risk for extinction and this report was released to the public in December 2014 with a negative 12-month finding indicating that listing under the Endangered Species Act was determined to be unwarranted.

f) Marine Mammals

Cetacean surveys:

In 2014, NEFSC continued work on the Atlantic Marine Assessment Program for Protected Species (AMAPPS), which is a partnership with the Bureau of Ocean Energy Management (BOEM), 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.

During 17 February–27 March 2014, as part of the AMAPPS project, the NEFSC conducted an aerial abundance survey utilizing the NOAA Twin Otter. Shelf waters from New Jersey to Nova Scotia were surveyed. Track lines were flown 183 m (600 ft) above the water surface, at about 200 kph (110 knots). The two-independent team methodology was used to collect the data. In Beaufort sea states of six and less, about 4900 km of on-effort track lines were surveyed. About 430 individuals within 155 groups of 11 species (or species groups) of cetaceans, seals and large fish were detected by one or both teams. The most regularly detected small cetacean species were white-sided dolphins (*Lagenorhynchus acutus*), bottlenose dolphins (*Tursiops truncatus*) and harbor porpoises (*Phocoena phocoena*); right whales (*Eubalaena glacialis*) and minke (*Balaenoptera acutorostrata*) whales were the most common large whales. No sea turtles were detected.

A winter aerial abundance survey was conducted on the NOAA Twin Otter during 4 December 2014–19 January 2015.

A shipboard abundance survey of marine mammals and sea turtles using the NOAA R/V *Henry B. Bigelow* was conducted during 11 March–3 April and 7 April–1 May 2014. The study area included waters from Cape Cod, MA to North Carolina and from the southern tip of Nova Scotia to the US Atlantic coastline. Track lines were surveyed at about 10 kts (18.5 km/hr), using the two-independent visual team line transect methodology to collect marine mammal and turtle data, while the one-team strip transect methodology was used to collect sea bird distribution and abundance data. At the same time passive acoustic hydrophones were used to detect vocal cetaceans. In addition, physical and biological oceanographic data were collected using a bongo net, visual plankton recorder, Multiple Opening/Closing Net Environmental Sensing System, Isaacs-Kidd midwater trawl, Conductivity, Temperature, and Depth Profiler, multifrequency echosounder, Van Veen benthic grab, and beam trawl. Over 4000 km of on-effort track lines were surveyed during the daytime with about 150 hours of passive acoustic recordings. The upper visual team detected 3,713 individuals within 626 groups of 31 species (or species groups) of cetaceans, seals and large fish. In addition 54 groups of vocally-active odontocetes from 5 species (or species groups) were heard with the hyrophones. Common dolphins (*Delphinus delphis*) and bottlenose dolphins were the most regularly detected small cetacean species. Fin whales (*Balaenoptera physalus*) and humpback whales (*Megaptera novaeangliae*) were the most common large whales. One loggerhead turtle (*Caretta caretta*) and an unidentified hard shell turtle were also detected. About 6940 birds within 2491 groups of 62 species (or species groups) were detected while on effort.

During 25–30 July 2014, the NEFSC conducted a short shipboard survey to document the relationships between the distribution and abundance of cetaceans, sea turtles and sea birds relative to their physical and biological environment, focusing on beaked whales on Georges

Bank. During over 800 km of surveyed track lines, there were 43 hours of passive acoustic recordings, and the visual observers detected over 1800 cetaceans and 800 birds and tracked six groups of Sowerby's beaked whales (*Mesoplodon bidens*) to document their dive time patterns, where the longest track was about 23 minutes.
A shipboard North Atlantic right whale (*Eubalaena glacialis*) cruise was conducted during 04–16 September aboard the University of Delaware UNOLS charter Ship *H.R. Sharp*. Principal objectives of the cruise were to obtain photo id and biopsy samples of North Atlantic right whales. Specific goals included: (1) Photographing and biopsy sampling of large cetaceans (mostly North Atlantic right whales) for individual identification; (2) Testing the use of sonobuoys for acoustic recording of right, 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. The primary survey areas included the Continental shelf break and canyons along the Southern Flank of Georges Bank, Atlantis Canyon, the Bear seamount, Corsair Canyon, the NE Peak, Georges and Franklin Basins across the EEZ and along the Northern edge of Georges Bank. The secondary survey areas included the Northeast Channel, Cashes and Jeffreys Ledges, and Stellwagen Bank.

The North Atlantic Right Whale Sighting Survey (NARWSS) is a NOAA Fisheries program, which locates and records the seasonal distribution of North Atlantic right whales off the northeastern coast of the United States. NARWSS flights conducted in 2014 followed systematic tracklines with randomized starting locations within 12 primary survey blocks: Cashes Ledge, Coastal Maine, Franklin Basin, Georges Basin, Georges Shoal, Great South Channel, Howell Swell, Jeffreys Ledge, Jordan Basin, Lindenkohl Basin, Rhode Island Sound, and Stellwagen Bank. During 2014, NARWSS flew 245 hours over 55 surveys, including a directed flight over right whales in Cape Cod Bay and two sawtooth flights in Atlantis Canyon. NARWSS detected 277 right whales (including possible duplicate sightings of the same individual), with 244 right whales sighted within survey blocks and 34 right whales sighted during transit to or from survey areas.

During January-March 2014, 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.

Cetacean bycatch and other analyses:
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 2014 included gillnets, 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*), short-beaked common dolphins, Atlantic white-sided dolphins (*Lagenorhynchus acutus*), 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.

Scarification analyses of right and humpback whales continued in 2014. These analyses are

used to monitor interactions between whales and fishing gear. Serious injury determinations were made on non-fatal large whale fishery interactions and vessel strikes, as well as bycaught small cetaceans to determine causes and extents of injuries.

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.

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

In 2014, acoustic data were collected via a number of different platforms. Archival acoustic recorders were deployed for varying lengths of time in Massachusetts Bay, the Great South Channel, and off the shelf break from Georges Bank to Hudson Canyon. Towed hydrophone array data were collected from two cetacean abundance surveys, in March/April and July. An autonomous acoustic technology project using glider technology is underway with the Woods Hole Oceanographic Institution (WHOI) to record, classify and remotely report low-frequency marine mammal vocalizations and collect oceanographic data. A glider deployment was conducted in Massachusetts Bay in December 2014. An ongoing project investigating the acoustic behavior of right whale mother-calf pairs was also continued. This research was conducted in collaboration with Dr. Susan Parks (Syracuse University), and involves boat-based acoustic data collection. Fieldwork was conducted in the Bay of Fundy, Cape Cod Bay, and on the U.S. Southeast calving grounds.

Beginning in 2014, a large, collaborative effort was initiated by the Passive Acoustics Group to compile existing archival passive acoustic data from the U.S. eastern seaboard for comprehensive analyses of migratory patterns of North Atlantic right whales. At least thirteen collaborators and institutions have contributed data to this effort. Temporal and spatial coverage by their different projects were not necessarily concurrent, but the periods with the most consistent coverage across as many regions as possible were selected for analysis. Analyses are underway.

Other analyses of archival data included the use spatially-explicit capture-recapture (SECR) methods for estimating the abundance of right whales in Massachusetts Bay; evaluating the spring/summer occurrence of baleen whales along the shelf break; assessing movements, calling behavior and seasonal migrations of North Atlantic minke whales. Work was also continued on using passive acoustics for identifying aggregations of spawning cod within Massachusetts Bay, a project that is conducted in collaboration with Massachusetts Division of Marine Fisheries.

Towed hydrophone array data were analyzed for the presence of deep-diving odontocetes, particularly sperm whales and beaked whales. Detections and localizations of sperm whales were used to derive abundance estimates; efforts were also initiated to integrate these data with concurrent visual observations from the shipboard line-transect surveys to create combined visual/acoustic abundance analyses. Detections of beaked whales were used to describe their distribution in slope and abyssal waters. Additionally, acoustic data corresponding to visually-verified single-species encounters were contributed to colleagues working on developing an automated echolocation and whistle classifier for the western North Atlantic.

Since 2007, the NEFSC has also been involved in an ocean noise project in the Stellwagen Bank National Marine Sanctuary (SBNMS). The objectives of this project are to map the ocean noise budget within the sanctuary, characterize various contributing noise sources

(biological and anthropogenic), and evaluate the noise impact on marine mammals in terms of their available communication range. Communication ranges were modeled for four species of baleen whales (right, fin, minke, and humpback whales) across six call types, and revealed the extent of loss of communication space for these whales under present-day noise conditions. A new project, initiated in 2014, is focused on the development of acoustic metrics to describe soundscape patterns in SBNMS. This project is being done in collaboration with the National Park Service and Stellwagen Bank National Marine Sanctuary.

Pinnipeds:
In 2014, one NEFSC aerial seal survey was conducted to monitor major gray seal (*Halichoerus grypus*) pupping colonies in Massachusetts and Maine coastal waters. NEFSC also collaborated with the Center for Coastal Studies to conduct monthly year-round surveys of gray seal and harbor seal (*Phoca vitulina*) haulouts in southeastern Massachusetts.

In August 2014, aerial surveys of the major haulout sites between Cape Ann, Massachusetts and Portsmouth, New Hampshire were conducted to obtain data on seal haul-out patterns over three consecutive mid-day tidal cycles.

In January 2014, a diverse group of researchers collaborated on a gray seal pup capture project on Muskeget Island, Massachusetts. Partners included NEFSC's Protected Species Branch, Massachusetts Institute of Technology, Mystic Aquarium, Marine Mammals of Maine, the University of New England, the Woods Hole Oceanographic Institution, and the University of Connecticut. 104 gray seal pups were captured, sampled and flipper-tagged. Samples contributed to MIT's work on influenza in migratory wild populations among other projects.

Work continued in 2014 on stomach content analysis of bycaught harbor and gray seals.

Bycatch estimation of harbor, gray and harp (*Pagophilus groenlandicus*) seals was conducted based on observed takes in the Mid-Atlantic Gillnet, Northeast Sink Gillnet, and Northeast and mid-Atlantic bottom trawl 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 2014, the NEFSC continued two gear and gear-related projects investigating methods to reduce sea turtle bycatch in fishing gear. These included: (1) an operational feasibility and comparative study of the performance of a rigid turtle excluder device (TED) 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 2014 the NEFSC conducted research related to turtle bycatch assessment. These included: (1) estimating turtle mortality rates in commercial gears using serious injury guidelines; (2) estimating bycatch of turtles in Mid-Atlantic bottom otter trawl and scallop trawl fisheries from 2009-2013. The NEFSC also continues to develop quantitative methods for assessing anthropogenic threats to sea turtles.

In support of AMAPPS priorities, NEFSC contributed to regional collaborations to deploy satellite tags on wild-captured loggerhead sea turtles (*Caretta caretta*) 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). The collaboration deployed twenty satellite

tags on loggerhead sea turtles collected in mid-Atlantic shelf waters (including 1 turtle in the far northern portion of the area).

h) Seabirds

Collaborative efforts between Stellwagen Bank National Marine Sanctuary, U.S. Fish and Wildlife Service, and NOAA Fisheries Northeast Fisheries Science Center identified areas of probable seabird-fishery interaction by integrating data from satellite-tagged great shearwaters (*Puffinus gravis*) and self-reported fishing locations from the New England sink gillnet fishery. An area constituting 1% of the Gulf of Maine was identified as having the highest seabird bycatch risk, which was further corroborated by contemporaneous fisheries observer data collected by the NOAA Fisheries Northeast Fisheries Science Center as part of core operations.

Collection of seabird data was conducted on board NOAA ships *Gordon Gunter* and *Henry B. Bigelow* as part of shipboard line-transect surveys in support of the AMAPPS project. During February–April 2014 on the Gordon Gunter about 4,000 km of track lines were covered that spanned waters from Massachusetts to Virginia, with 6,940 sightings of seabirds of which herring gull (*Larus argentatus*), northern gannet (*Morus bassanus*), and dovekie (*Alle alle*) were the most frequent. During 25–30 July 2014 on the Henry B. Bigelow about 800 km of track lines were covered along the southern edge of Georges Bank, with 802 sightings of seabirds of which ~90% belonged to one of five species or species groups: Wilson's Storm-Petrels (*Oceanites oceanicus*), Cory's Shearwaters (*Calonectris diomedea*), Audubon's Shearwaters (*Puffinus lherminieri*), unidentified storm-petrels, and Great Shearwaters (*Puffinus gravis*). These data were archived in the Compendium of Avian Occurrence Information for the Continental Shelf Waters along the Atlantic Coast of the United States, which supports marine spatial planning efforts by various governmental agencies.

In 2014 development of analytical methods by NOAA Fisheries Northeast Fisheries Science Center to provide comprehensive estimates of seabird-fisheries interactions was ongoing.

3. Studies of Fishing Operations

In 2014, NEFSC Observers were deployed on 3,260 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 218 marine mammal incidental takes, 27 sea turtle incidental takes, and 61 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 1,658 trips aboard commercial fishing vessels in 2014. On these trips there were 155 marine mammal, nine sea turtle, and 119 seabird incidental takes documented.

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

In the sink anchored gillnet fishery, 742 trips were observed with a total of 3,259 gear retrievals by Observers. There were 148 observed marine mammal takes in this fishery (95 gray seals, 19 harbor seals, 11 harbor porpoises, 9 harp seals, seven unidentified seals, five common dolphins, one whitesided dolphin and one unidentified dolphin). There were also two loggerhead turtles, one unidentified hard-shell turtle and 42 seabird takes observed in this fishery.

At-Sea Monitors observed 838 trips in the sink anchored gillnet fishery with 3,470 gear retrievals. There were 131 marine mammal (65 gray seals, 41 harbor seals, 16 harbor

porpoises, seven common dolphins, one whitesided dolphin and one unidentified seal), nine sea turtles (eight loggerhead turtles and one unidentified hard-shell turtle) and 90 seabird

(79 of which were greater shearwaters) incidental takes recorded in this fishery by Monitors.

b. Float Drift Gillnet Fishery

There were 17 floating drift gillnet trips with 49 gear retrievals observed in 2014. There were no marine mammal, sea turtle, or seabird takes observed.

No Monitors deployed on float drift gillnet trips in 2014.

c. Otter Trawl Fisheries

In the bottom otter trawl fishery 1,439 trips were observed with a total of 10,621 gear retrievals recorded by Observers. In addition, there were 34 midwater trawl trips with 79 gear retrievals, 19 scallop trawl trips with 100 gear retrievals, three shrimp bottom otter trawl trips with 32 gear retrievals, five twin trawl trips with 82 gear retrievals, nine haddock separator trawl trips with 234 gear retrievals and two Ruhle trawl trips with 19 gear retrievals observed in 2014.

In the bottom otter trawl fishery, there were 57 observed marine mammal takes (34 common dolphins, five Risso's dolphins, four pilot whales, three bottlenose dolphins, three gray seals, two harbor seals, two whitesided dolphins, two unidentified dolphins, one finback whale and one humpback whale). There were also 20 loggerhead turtles, one green turtle, one Kemp's ridley and three seabird takes in this fishery. In the mid-water trawl fishery there was one seabird take. In the scallop trawl fishery there no incidental takes observed. No marine mammal, sea turtle or seabird takes were observed in the shrimp bottom otter trawl fishery. On twin trawl trips there was one loggerhead turtle take observed. There were no incidental takes observed on haddock separator trawl trips. There was one common dolphin take on the Ruhle trawl trips in 2014.

At-Sea Monitors deployed on 757 bottom otter trawl trips with 8,375 gear retrievals, 23 haddock separator trawl trips with 709 gear retrievals and one Ruhle trawl trip with 19 gear retrievals in 2014. There were 20 marine mammal (seven common dolphins, four pilot whales, three whitesided dolphins, two harbor porpoises, two gray seals, one harbor seal and one unidentified seal) and six seabird takes recorded by Monitors in the bottom otter trawl fishery. There were two common dolphins, one gray seal and one seabird take in 2014. There were no incidental takes documented by Monitors on Ruhle trawl trips in 2014.

d. Sea Scallop Dredge Fishery

In the sea scallop dredge fishery, 481 trips were observed with a total of 35,954 gear retrievals. There was one harp seal take and six seabird takes observed in this fishery.

No Monitors deployed in the scallop dredge fishery in 2014.

e. Scottish Seine Fishery

No Scottish seine trips were covered by Observers or Monitors in 2014.

f. Drift Sink Gillnet Fishery

In the drift sink gillnet fishery in 2014, Observers were deployed on 201 trips with a total of 1,233 gear retrievals. There were one harbor porpoise and nine seabird takes in this fishery.

Monitors were deployed on 22 trips with a total of 251 gear retrievals. There were one harbor porpoise and 22 seabird takes documented by Monitors in this fishery.

g. Anchored Floating Gillnet Fishery

There were 11 anchored floating gillnet trips with 27 gear retrievals observed in 2014. No marine mammal, sea turtle, or seabird takes were observed in this fishery.
No Monitors deployed on anchored floating gillnet trips in 2014.

h. Mid-water Pair Trawl Fishery

In 2014, there were 137 mid-water pair trawl trips observed with a total of 370 gear retrievals. Eight takes (four pilot whales, one harbor seal, two unidentified seals and one unidentified dolphin) were observed in this fishery. No sea turtles or seabirds were documented.

No Monitors were deployed on mid-water pair trawl trips in 2014.

i. Bottom Longline Fishery

In the bottom longline fishery in 2014, 23 trips were observed with a total of 188 gear retrievals. There were no marine mammal, sea turtle or seabird takes observed.

At-Sea Monitors covered a total of 16 bottom longline trips and 60 gear retrievals in 2014. There were no marine mammal, sea turtle or seabird takes observed by Monitors.

j. Beach Haul Seine Fishery

No beach haul seine trips were covered by Observers or Monitors in 2014.

k. Pound Net Fishery

No pound net trips were covered by Observers or Monitors in 2014.

l. Handline Fishery

In 2014, there were 12 handline trips and 78 gear retrievals, one auto-jig handline trip and 12 gear retrievals and one trolling trip and six gear retrievals observed. No marine mammals, sea turtles or seabirds were taken in these fisheries.

Monitors covered one handline trip and seven gear retrievals in 2014. There were no documented takes in this fishery in 2014.

m. Herring Purse Seine Fishery

In 2014, there were 28 herring purse seine trips with 71 gear retrievals observed. There were two gray seal takes observed in this fishery. No sea turtles or seabird takes were observed.

No herring purse seine trips were covered by Monitors in 2014.

n. Menhaden Purse Seine Fishery

No menhaden purse seine trips were covered by Observers or Monitors in 2014.

o. Tuna Purse Seine Fishery

Five tuna purse seine trips with seven gear retrievals were observed in 2014. There were no marine mammal, sea turtle or seabird takes observed.

No tuna purse seine trips were covered by Monitors in 2014.

p. Lobster Pot Fishery

In 2014, there were 55 lobster pot trips with 1,624 gear retrievals observed. There was one leatherback turtle take and no marine mammal or seabird takes in this fishery.

No lobster pot trips were covered by Monitors in 2014.

q. Fish Pot Fishery
In 2014, 13 fish pot trips with 113 gear retrievals were observed. No takes were documented.

No fish pot trips were covered by Monitors in 2014.

r. Conch Pot Fishery
In 2014, 19 conch pot trips and 255 gear retrievals were covered by Observers.

No conch pot trips were covered by Monitors in 2014.

s. Red Crab Pot Fishery
No red crab pot trips were covered by Observers or Monitors in 2014.

t. Blue Crab Pot Fishery
No blue crab pot trips were covered by Observers or Monitors in 2014.

u. Clam Dredge Fishery
No clam dredge trips were covered by Observers or Monitors in 2013.

v. Scallop Beam Trawl Fishery
No scallop beam trawl trips were covered by Observers or Monitors in 2014.

w. Other Dredge Fisheries
In 2014, Observers covered one oyster dredge trip with 32 gear retrievals and two crab dredge trips with 23 gear retrievals. There were no takes documented on these trips.

No other dredge trips were covered by Monitors in 2014.

4. Observer estimation of catch on NAFO Div 3 trips.

a. The checker pen is measured and total volume is calculated prior to the catch being dumped onboard (The F/V Titan uses varying size checker pens as they can change the size by adding or removing pen boards).

b. Once the catch is dumped the observer takes the depth of the checker pen (filled with catch) in 10 random locations within it using a measuring stick. The average depth of the fish in the checker pen is then calculated. The total volume of the catch is then calculated by multiplying the length times the width of the checker pen times the depth of the catch.

c. The observer then fills (depending on amount of catch) 1.47 cu. ft. baskets with the catch from random locations throughout the checker pen. The number of baskets varies from 8 to 15 (if the catch is very low the basket number could be less). The number of baskets used is then multiplied by the volume of one basket to obtain the Total Volume Subsampled. The fish are then separated by species and whether they are kept or discarded. The discard size is determined by the observer according to the legal U.S. fisheries regulations. The kept and discards of each species are weighed and recorded.

d. The kept and discarded catch weights are then calculated by the following formula:

1) A Sample Multiplier is calculated by (Total Volume (see # 2 above) / total Subsample Volume (see # 3 above))

2) The weight of each species Subsampled is then multiplied by the Sample Multiplier to calculate the Estimated Total Weight for that species and catch disposition.

3) The percent Subsampled can be calculated by dividing the Total Subsample Volume by the Total Volume of the catch.

5. 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 2014 include sea scallop, Gulf of Maine haddock, butterfish, tilefish and Northern shrimp.

For the sea scallop assessment, region-scale towed camera (HabCam) surveys were used for the first time. Dredge survey data from intensive area specific surveys conducted by the Virginia Institute of Marine Science were integrated into the dredge survey indices. CASA stock assessment models indicated that sea scallops were neither overfished nor was overfishing occurring. Ongoing sea scallop research at NEFSC includes geostatistical estimation methods for towed camera data, methods to combine automated and manual counts from optical data, scallop survey dredge efficiency from paired dredge/HabCam data, investigation of possible recruitment "spillover" from Mid-Atlantic rotational closures, and effects of fishing on scallop growth.

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 2014, stock assessments conducted and reviewed through the TRAC process included Eastern Georges Bank cod, Eastern Georges Bank haddock, and Georges Bank yellowtail flounder. Three stocks were updated through a separate process and included Pollock, Gulf of Maine winter flounder and Georges Bank winter flounder. Other stock assessments in 2014 vetted in regional bodies included scup, black sea bass, bluefish, spiny dogfish, and striped bass.

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 2014 focused on (1) a fish community survey within the Penobscot River estuary; (2) marine telemetry; and (3) monitoring of fishery removals on the high seas. 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, all highlight 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 Atlantic salmon 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. 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

The Northeast Cooperative Research Program (NCRP) began in 1999. NCRP supports collaborations among fishermen and scientists to enhance marine fisheries science used in stock assessments, bycatch reduction, and for use by marine fisheries managers. Additionally, NCRP increases communication and learning among fishing professionals in the region while leveraging competencies among diverse partners. NCRP research is supported by United States Federal Budget and fishery resource allocations that are 'set aside' and used to fund research programs (Research Set-Asides). NCRP research is conducted both internally to the Northeast Fisheries Science Center (NEFSC) and coordinated externally with academic institutions, states' marine resource agencies, private non-governmental research organizations (NGOs) and fishing industry partners. Cooperative research addresses fishery dependent, fishery independent, fishery biology and oceanography, and bycatch reduction/education oriented studies.

1. Projects Coordinated by Northeast Fisheries Science Center

Fishery Dependent Data**:** The NEFSC Study Fleet and an on-going collaborative effort between the Pacific States Marine Fisheries Commission (PSMFC), Northeast Cooperative Research Program (NCRP), and NEFSC Data Management Services (DMS) continue to support reporting of higher resolution fishery dependent data from Gulf of Maine, Georges Bank, Mid-Atlantic and Southern New England fleets. A study fleet is a subset of fishing vessels from which high quality, self-reported data on fishing effort, location, gear characteristics, catch, and biological observations are collected. This effort expands electronic vessel reporting and the collection of finer-scale fisheries dependent data by use of our Electronic Logbook System (FLDRS) used by fishing captains to record, and transfer more accurate and timely fishery-based data. A total of 83 vessels are currently equipped to report in near-real-time with plans to expand to an additional 64 vessels. FLDRS software modifications were identified for various fisheries, and the NCRP provides training to partner institutions' technical staff to support vessel operations. Most vessels record tow-by-tow catch and discard data, while a subset only provide sub-trip aggregate reporting that is required for electronic Vessel Trip Reports (eVTRs). Tow-by-tow reporting is supplemented by temperature-depth data using specially designed sensor probes that are deployed on mobile gear. These data are valuable to the fishing industry and are shared with oceanographic modelers, stock assessment scientists and other researchers to model ecosystem drivers of species distribution and co-occurrence, and to aid in bycatch reduction.

Fishery Independent Data**:** In October of 2014, a research project to compare the relative efficiency of three different survey methods for flatfish and skate species was

conducted within a roughly 2000 km2 area in Closed Area II of Georges Bank. The surveyed area was previously identified as a high density yellowtail flounder habitat during the Pilot Flatfish Survey on Georges Bank in the summer of 2013. An initial optical survey of the area was conducted using the HABCAM vehicle, and approximately 500 nm of transects were completed. Subsequently, a total of 56 randomly-selected side-by-side tows were conducted within the same area by the NOAA ship Henry Bigelow and the F/V Hera. The Bigelow used the standard bottom trawl used during the spring and autumn Bottom Trawl Surveys conducted by the NEFSC. The trawl used aboard the Hera was a two-seam, two-bridle flounder net with a sweep consisting of 4" rubber cookies; this was the same trawl used on the previous pilot flatfish survey and was originally selected in close consultation with fishing industry representatives. The results from this project will be used to help understand the relative catchability of the three gears used and, in conjunction with the results of other catchability studies, help stock assessment authors in the interpretation of standard bottom trawl survey results.

An experiment aimed at quantifying the herding efficiency of flatfish by the NEFSC survey trawl bridles was conducted during autumn 2014 aboard the F/V Karen Elizabeth. Using a blocked design, the standard survey bridle length, 36.6m, was compared to two longer bridle lengths, 58.5m and 80.5m. One tow of each bridle length was conducted per block at equal towing speed and duration. Bridle angle and net width were held constant at approximately 12° and 13m, respectively, at each bridle length in an effort to maintain equal bridle efficiency, equal area swept by the net width and equal net efficiency for each length configuration. Restrictor ropes made of positively buoyant, 9/16" Tenex rope, were connected between the trawl doors to define and maintain proper door spread at each bridle configuration for the duration of the study. A total of 77 blocks were sampled on eastern Georges Bank and south of Martha's Vineyard, producing data for 5 species of flatfish: yellowtail flounder, winter flounder, summer flounder, windowpane flounder and fourspot flounder. Underwater video observations were recorded from 20 tows at various positions on the trawl net, doors and bridles. Catch rates were significantly higher during nighttime tows for each of the flatfish species other than yellowtail flounder. Preliminary results suggest that herding efficiency of the NEFSC survey trawl bridles is relatively low for these species of flatfish. Data analyses are ongoing to estimate species specific bridle efficiency, particularly with regards to differences between daytime and nighttime and to understand bridle bottom contact in relation to flatfish herding efficiency.

Fishery Biology and Oceanography**:** Vessels participating in the study fleet program have also contributed to an enhanced biological sampling of commercially important species. Several assessments of flatfish stocks, which were previously hampered by survey timing and commercial retention prohibition, have benefited from this additional sampling effort. Enhanced reproductive sampling of flatfish stocks (yellowtail, winter, and summer flounders) resulted in revised biological reference points for stock assessment modeling. Length/weight regressions and other conversion parameters are also being updated. These enhanced biological sampling data have been used to confirm assumptions of age and growth used in stock assessment models.

The NCRP supported a cooperative initiative to tag spiny dogfish (*Squalus acanthias*) in the Gulf of Maine, Southern New England, and Georges Bank in 2011-2012. The purpose of this effort was to answer long-standing questions about stock structure, movement patterns, and life history of this species. This program is important in order to update and improve dogfish stock assessments. There were 150 recaptures during 2014, demonstrating considerable movement between the three tagging areas.

A project to study ecosystems factors of Atlantic cod spawning aggregations in relation to fishing interactions was begun in the fall of 2014. This is a novel collaborative effort among NEFSC, Massachusetts Division of Marine Fisheries, University of Massachusetts (School of Marine Science and Technology), and The Nature Conservancy. This study uses passive and active hydro-acoustic telemetry technology and autonomous underwater vehicles (AUV) or oceanographic gliders, equipped with sensors to collect water temperature, depth, and salinity as well as hydrophones to detect presence of fish tagged with radio transmitters. Up to 300 codfish will be tagged and tracked by both AUV and a fixed hydrophone array placed in Massachusetts Bay. The goal is to provide fine-scale and temporally specific information on cod spawning aggregations and to aid in creating a seasonal fishery closure area aimed at protecting this cod stock component.

Several cooperative research projects 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, and determine the thermal niche availability of NEFSC trawl survey data for individual species.

Both eMOLT and the NCRP Study Fleet are sharing these important data with IOOS, NERACOOS, and MARACOOS. Over several years, the Study Fleet has collected over 2.5 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 that 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.

In 2014, the NCRP teamed up with two commercial fishermen to successfully complete the first season of a pilot longline survey in the western and central Gulf of Maine. Forty-five base stations, 21 alternate stations, and 8 bait-type test stations were sampled where catches of species of interest such as cusk, wolfish, cod, white hake, thorny, winter, and little skate, halibut, and dogfish were expected to be high.

This industry-based survey built upon previous and ongoing cooperative longline sampling, and used methods and sampling gear consistent with that of the Eastern Gulf of Maine Sentinel Survey Fishery conducted by the Penobscot East Resource Center and the University of Maine's School of Marine Sciences to collect catch and biological data. Sampling stations included both hard and soft bottom, and efforts were made to be consistent with the coverage of the NEFSC bottom trawl survey in terms of stations per unit area. At each site, approximately one nautical mile of gear was set, covering a distance roughly equivalent to that of a bottom trawl survey tow. The industry-based survey timing was coordinated with the NEFSC research vessel Henry Bigelow's survey schedule as much as possible to provide complementary sampling that can be compared to indices from the trawl survey.

This survey is also intended to increase the understanding of age, growth, and maturity for some of the target data-poor species. Samples obtained through this work for species of concern, such as cusk, may be particularly helpful in developing proactive conservation measures and informing protected species decisions.

2. External Projects

Fishery Independent Data**:** Numerous projects funded by NCRP and coordinated by states and academic partners were conducted in 2014. For example, a 16 year time series Inshore Trawl Survey, in Maine and New Hampshire waters, sampled inshore areas. This inshore trawl survey is conducted by the Maine Department of Marine Resources. The University of Maine/Penobscot East Resource Center's Eastern Maine Sentinel Survey was augmented with jig stations in the shallower depths where longline and lobster gear conflicts limited sampling. This hook and line sampling was modeled after similar surveys on the west coast for Pacific rockfish and was felt to be a worthwhile addition to the program to inform future sampling design decisions. The Science Center for Marine Fisheries Science (SCeMFiS) conducts marine ecosystem studies through academic scientists at the University of Southern Mississippi and the Virginia Institute of Marine Science while collaborating with industry groups in the Mid-Atlantic and Southern New England. Current projects involve surf clam and ocean quohog surveys and survey data processing and design questions, as well as work on survey methodologies for black sea bass.

Fishery Bycatch Reduction and Education: Conservation engineer or bycatch reduction programs wrapped up their efforts in 2014. The Gear Conservation Engineering and Demonstration Network (GEARNET), led by the Gulf of Maine Research Institute, Massachusetts Division of Marine fisheries, and UMass-Dartmouth – School for Marine Science and Technology, focused on outreach and extension services to encourage adoption of modified gears and fuel consumption improvements. The REDNET group, led by the Massachusetts Division of Marine Fisheries, UMass Dartmouth – School for Marine Science and Technology, and Maine Department of Marine Resources is focused on methods to allow small redfish to escape at depth to maximize survival, outreach to the redfish industry, and exploring processing capabilities. The Squid Trawl Network (STN), led by Cornell University Cooperative Extension, developed an information exchange program to share and post gridded locations of high bycatch for scup, butterfish and river herring during 2013. The STN also developed oceanographic models to predict co-mingling of butterfish and squid. This effort ultimately resulted in predictive models of thermal habitat for these two species, and was used to enhance stock assessment for butterfish, resulting in adjusted biomass estimates and redefinition of stock status.

The Marine Resource Education Program (MREP) is a highly successful and innovative program that has demonstrated marked success as a mechanism to inform stakeholders about marine fisheries science and management processes.

3. Research Set-Aside (RSA) Programs Cooperative Research Projects

The NCRP manages the RSA programs in the Northeast, the priorities of which are established through the Mid-Atlantic Fisheries Management Council's Research Set-Aside committee, RSA species oversight committees, and the Northeast Fisheries Management Council's Research Steering committee. In 2014, programs for sea scallops, monkfish, Atlantic herring, and mid-Atlantic multispecies were operational.

The monkfish RSA program supported tagging projects to study movements between stock areas, age and growth, and influences on spawning by lunar cycles and water temperatures. The scallop RSA program supported research on scallop dredge and sea turtle interactions, grey meat causation, ecology of Atlantic sea scallops with respect to population enhancements, rotational area surveys to estimate harvestable biomass, and spatiotemporal fleet management to reduce yellowtail flounder bycatch. The herring RSA program support monitoring of herring harvest and bycatch of river herring through port sampling. The Mid-Atlantic RSA program supported NEAMAP

trawl survey and a fixed gear (ventless fish pots) survey to address a data poor stock assessment of black sea bass.

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 2014. The complete package may be accessed at http://nft.nefsc.noaa.gov/ (note that a password is no longer required).

Table 1 Catches of species not included in the Status of the Fisheries Section by NAFO Div in Subarea 3.

Div.	Species	Retained	Discarded	Total
3L	wolffishes		0.608	0.608
3L	Roughhead grenadier		0.594	0.594
3M	wolffishes		0.136	0.136
3N	Blue shark		0.290	0.290
3N	Atlantic wolffish		0.068	0.068
3N	American goosefish	0.192		0.192
3N	Wolffishes		10.179	10.179
3N	Northern wolffish		11.991	11.991
3N	Spotted wolffish		2.436	2.436
3N	Black dogfish		2.394	2.394
3N	Crab, uncl		0.003	0.003
3N	Sea Raven		0.289	0.289
3N	Greenland halibut		3.717	3.717
3N	Greenland shark		10.291	10.291
3N	Sea Cucumber		0.381	0.381
3N	Sculpins		0.180	0.180
3N	Pelagic Fish Uncl		0.003	0.003
3N	Porbeagle		0.250	0.250
3N	Redfishes		0.345	0.345
3N	Roughhead grenadier		10.257	10.257
3N	Swordfish		0.102	0.102
3N	Cusk	2.303	0.529	2.832
3O	Blue shark		0.297	0.297
3O	Northern wolffish		1.357	1.357
3O	Wolffishes		0.180	0.180
3O	Cusk	0.145	0.105	0.250
3O	Greenland halibut		0.201	0.201
3O	Greenland shark		1.385	1.385
3O	Roughhead grenadier		0.141	0.141

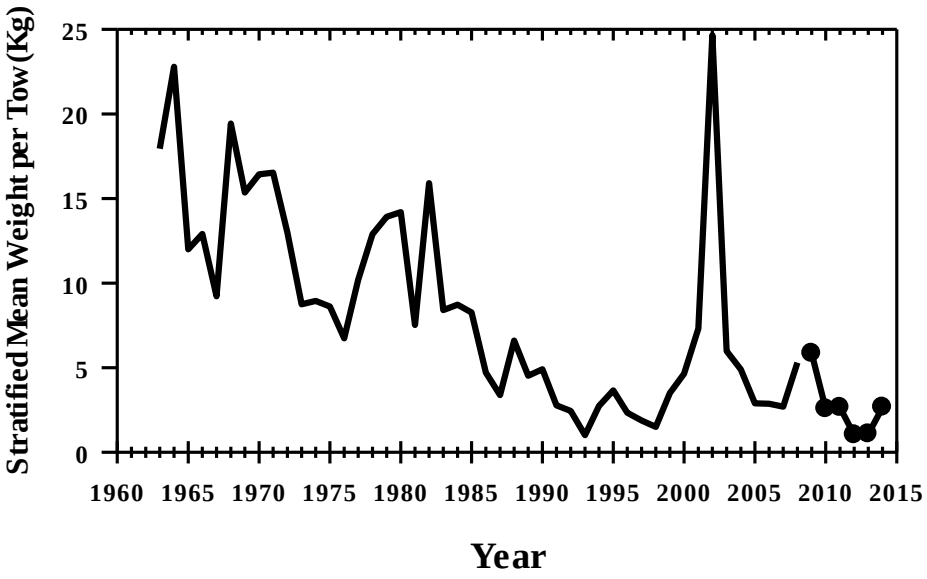

Figure 1. NEFSC autumn bottom trawl survey biomass indices for Gulf of Maine cod.

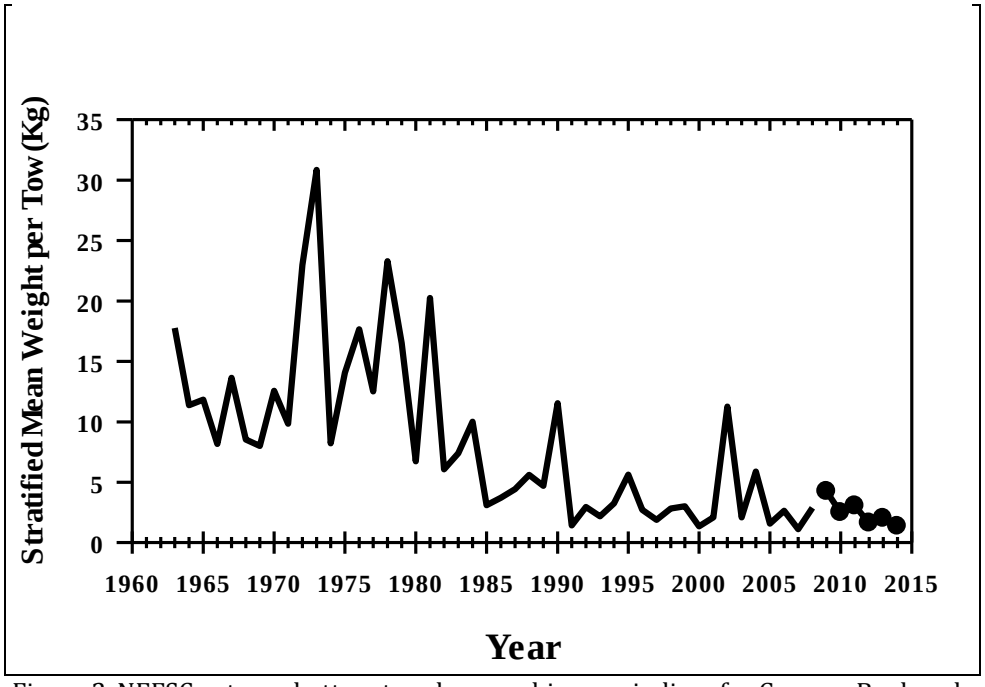

Figure 2. NEFSC autumn bottom trawl survey biomass indices for Georges Bank cod.

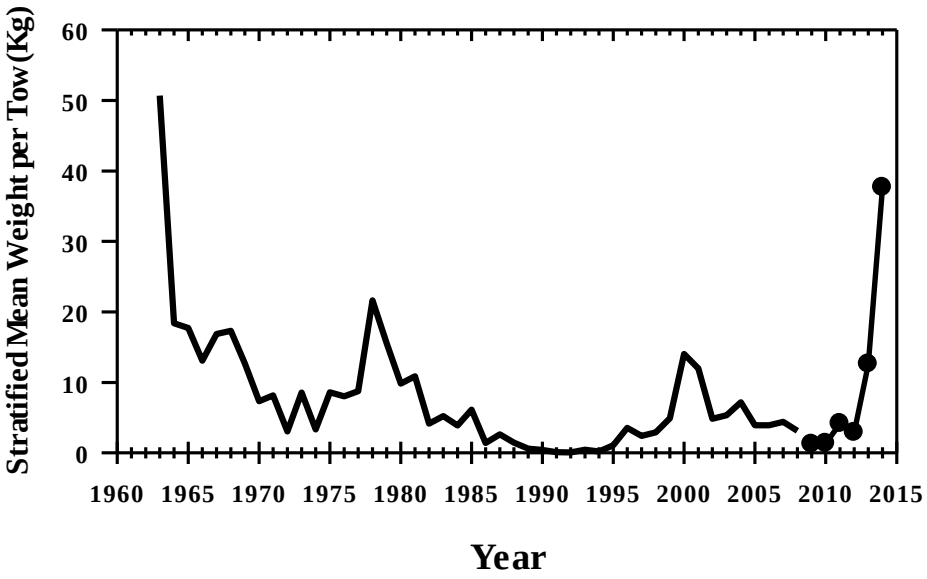

Figure 3. NEFSC autumn bottom trawl survey biomass indices for Gulf of Maine haddock.

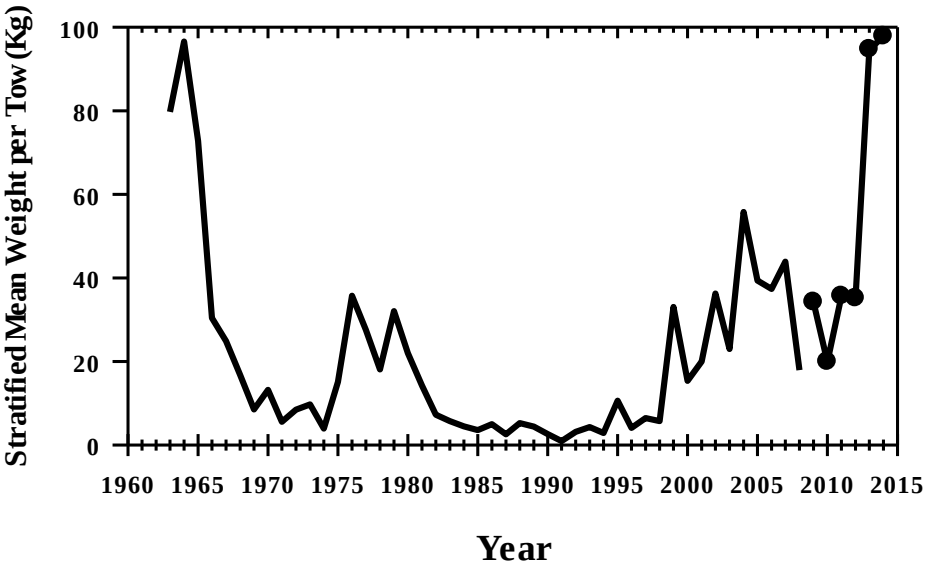

Figure 4. NEFSC autumn bottom trawl survey biomass indices for Georges Bank haddock.

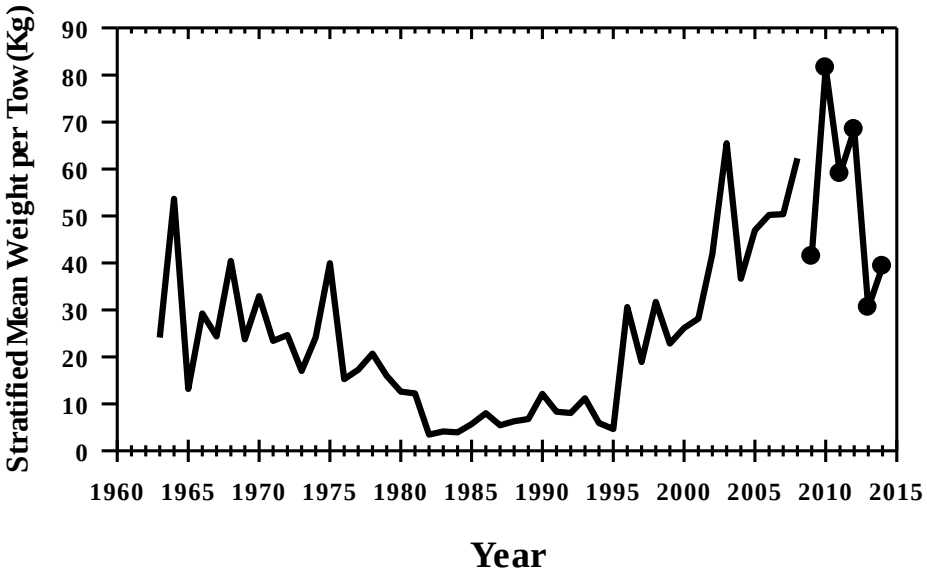

Figure 5. NEFSC autumn bottom trawl survey biomass indices for Acadian redfish.

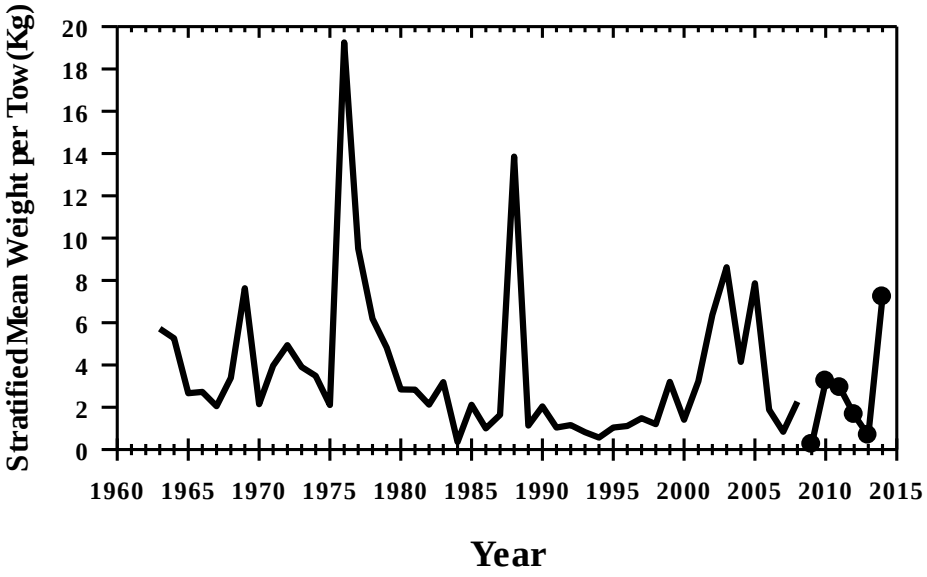

Figure 6. NEFSC autumn bottom trawl survey biomass indices for pollock.

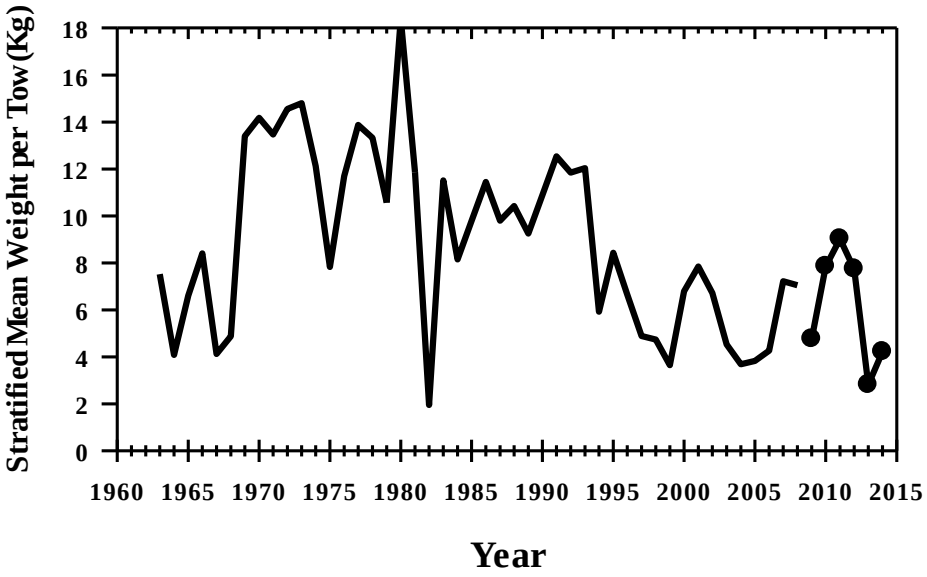

Figure 7. NEFSC autumn bottom trawl survey biomass indices for white hake.

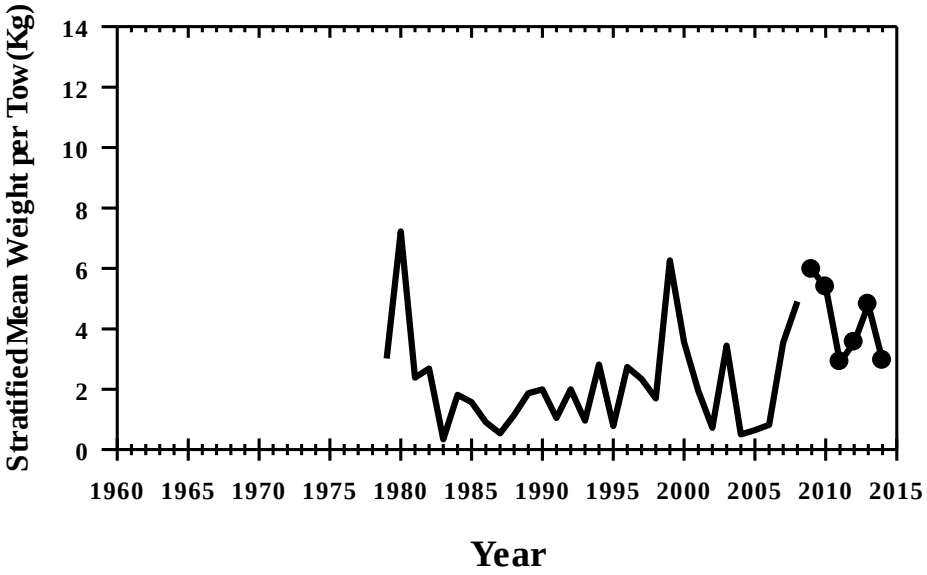

Figure 8. NEFSC autumn bottom trawl survey biomass indices for Cape Cod-Gulf of Maine yellowtail flounder.

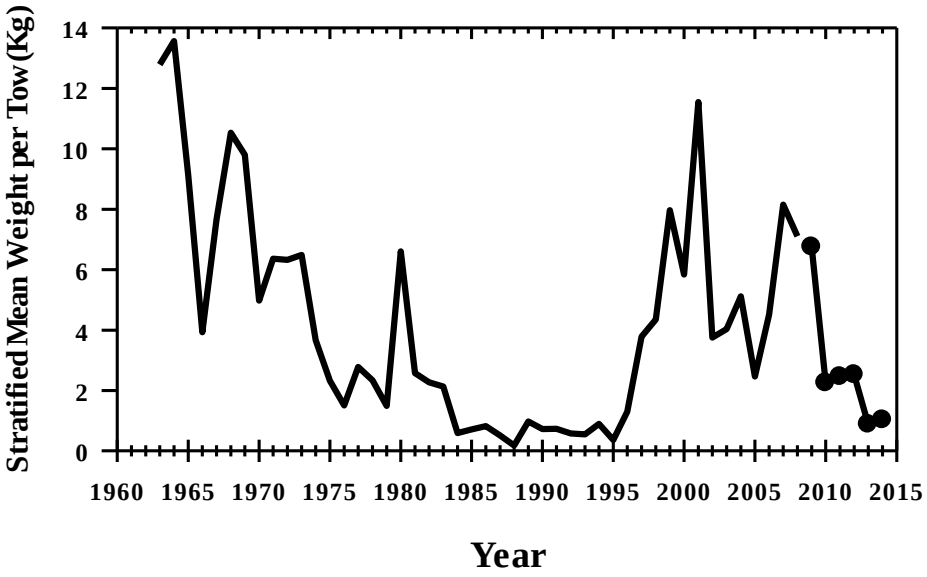

Figure 9. NEFSC autumn bottom trawl survey biomass indices for Georges Bank yellowtail flounder.

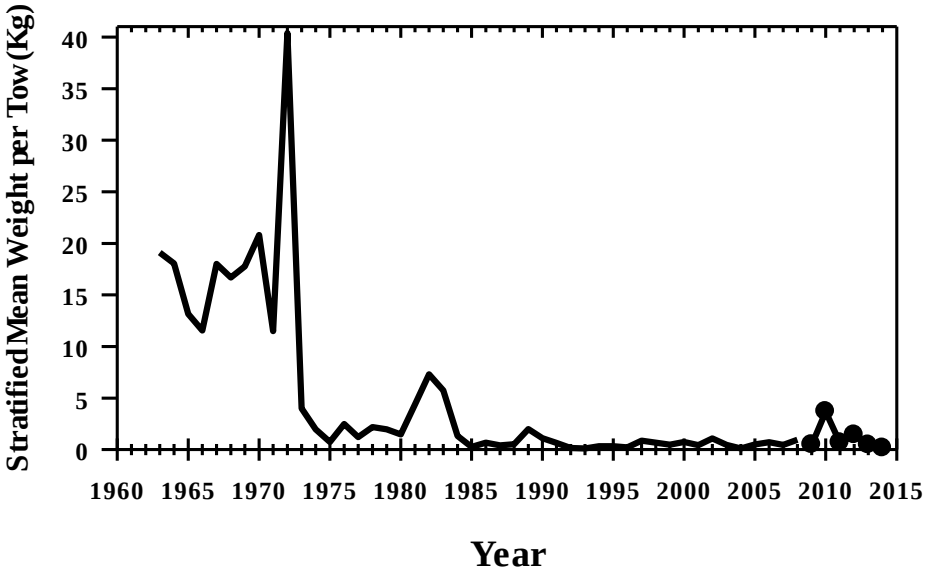

Figure 10. NEFSC autumn bottom trawl survey biomass indices for Southern New England-Mid-Atlantic yellowtail flounder.

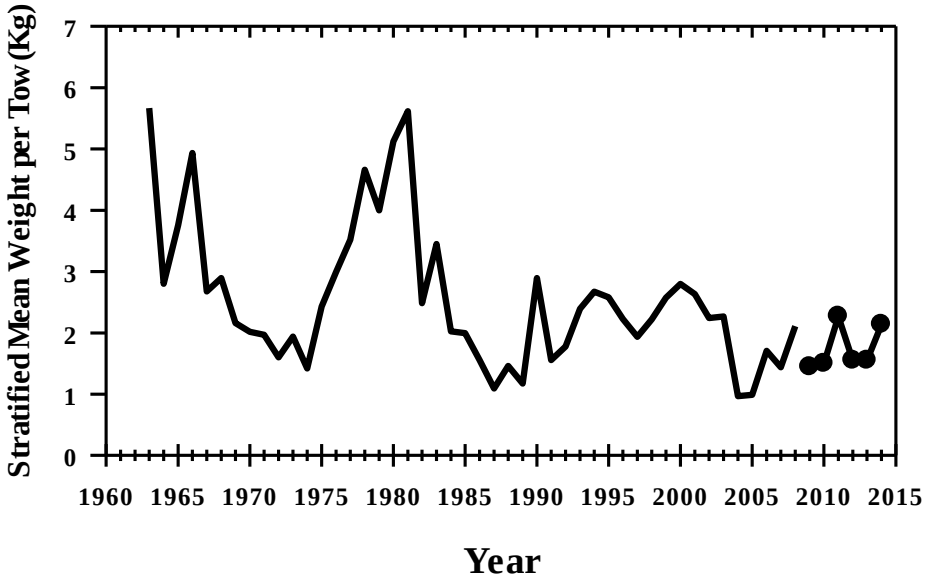

Figure 11. NEFSC autumn bottom trawl survey biomass indices for American plaice.

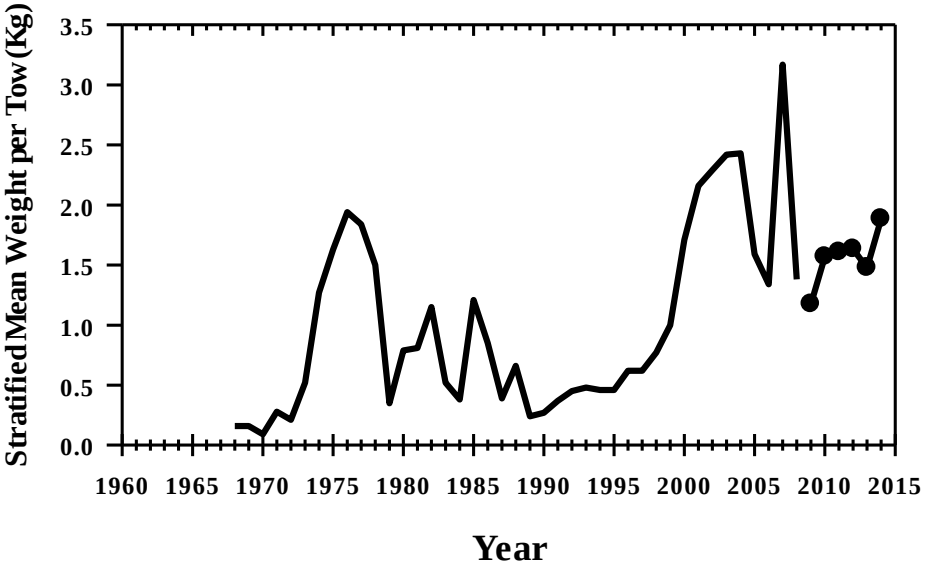

Figure 12. NEFSC spring bottom trawl survey biomass indices for summer flounder.

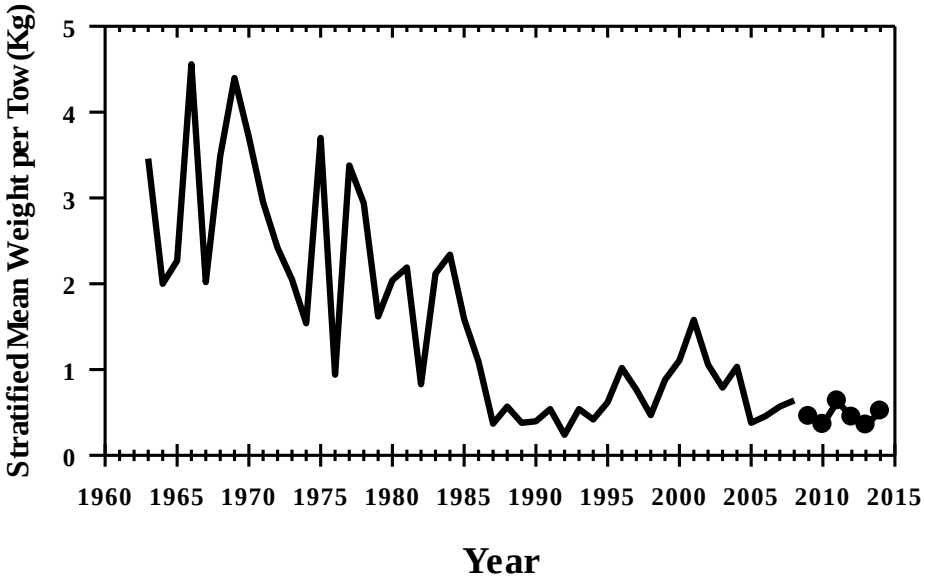

Figure 13. NEFSC autumn bottom trawl survey biomass indices for witch flounder.

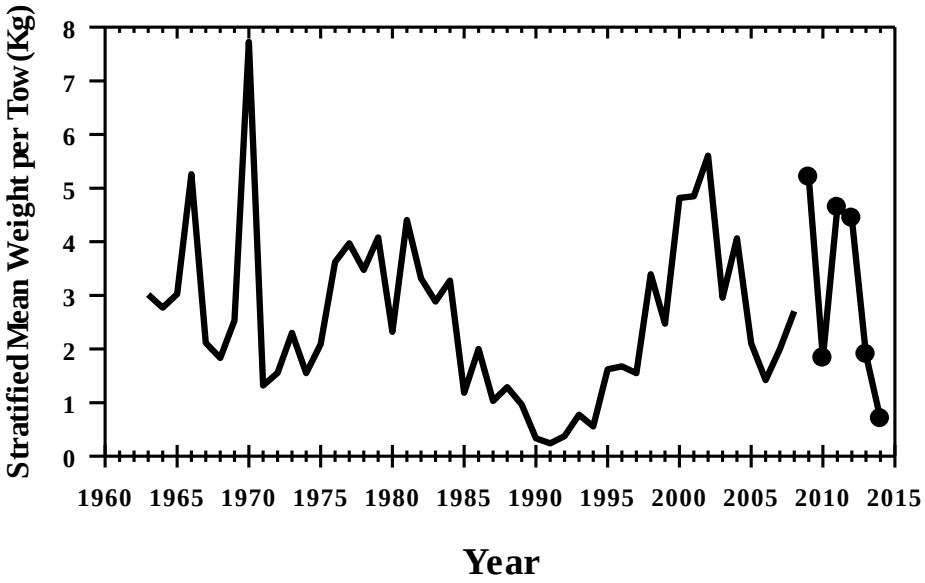

Figure 14. NEFSC autumn bottom trawl survey biomass indices for Georges Bank winter flounder.

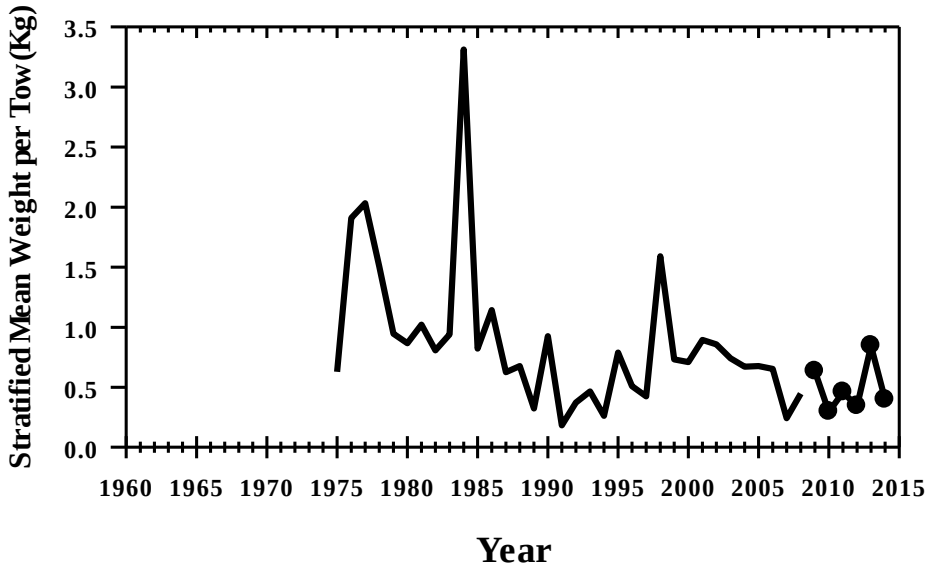

Figure 15. NEFSC autumn bottom trawl survey biomass indices for northern windowpane flounder.

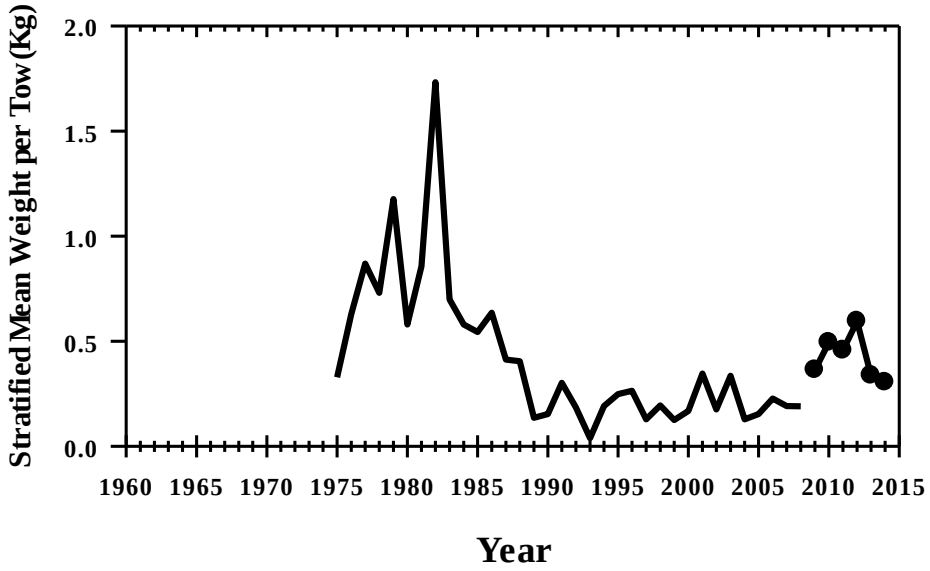

Figure 16. NEFSC autumn bottom trawl survey biomass indices for southern windowpane flounder.

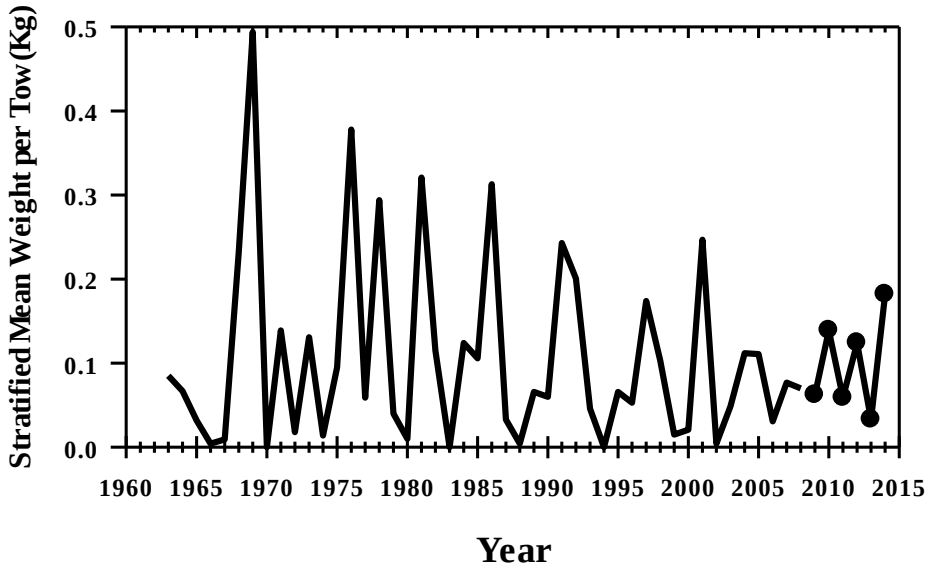

Figure 17. NEFSC autumn bottom trawl survey biomass indices for Atlantic halibut.

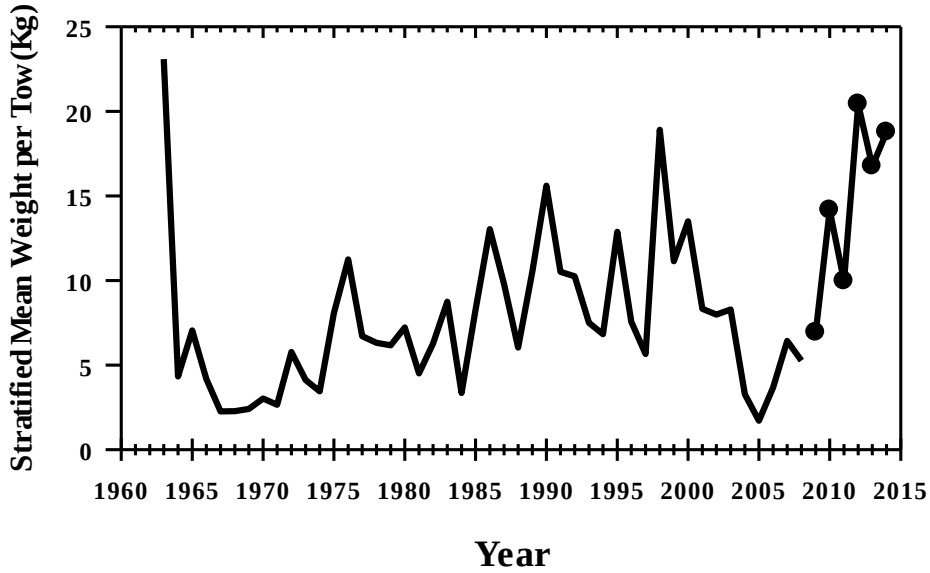

Figure 18. NEFSC autumn bottom trawl survey biomass indices for northern silver hake.

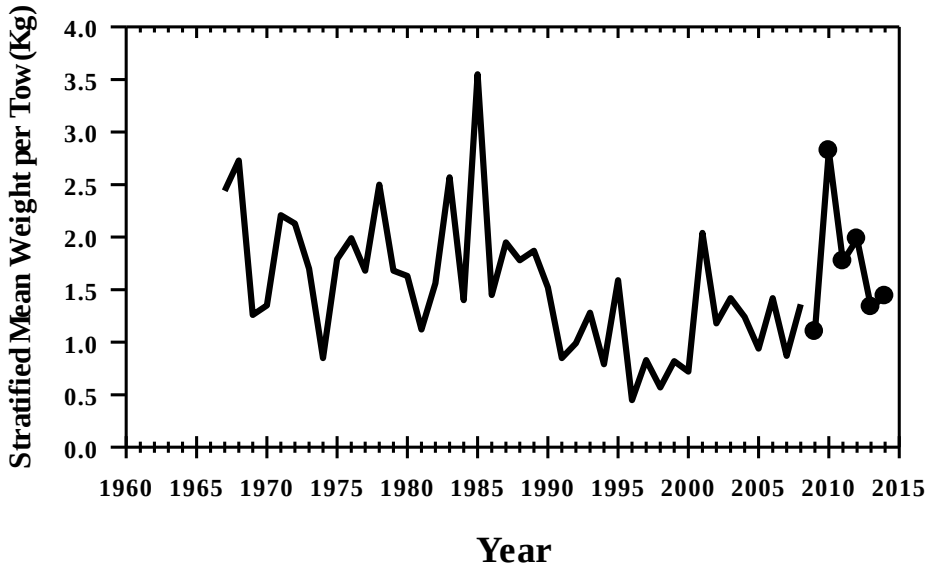

Figure 19. NEFSC autumn bottom trawl survey biomass indices for southern silver hake.

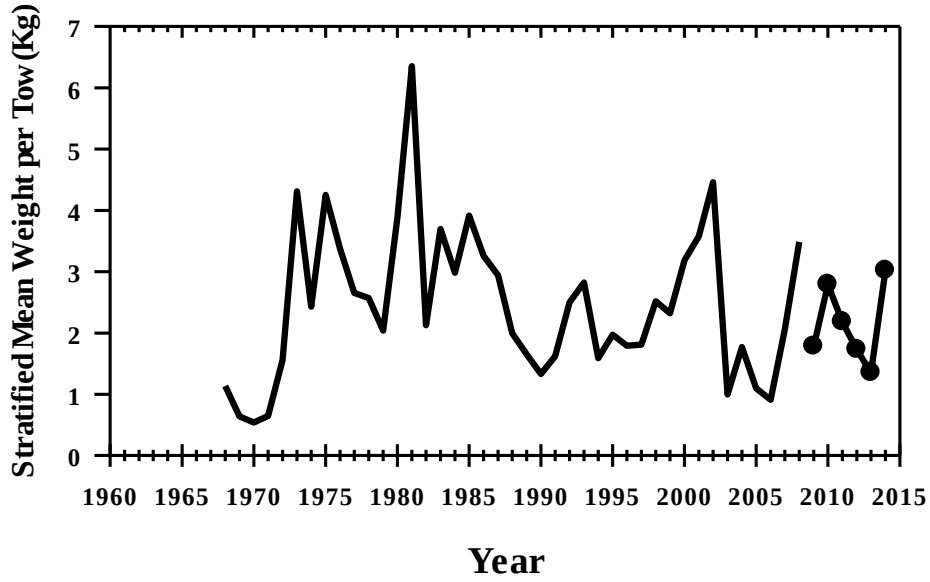

Figure 20. NEFSC spring bottom trawl survey biomass indices for northern red hake.

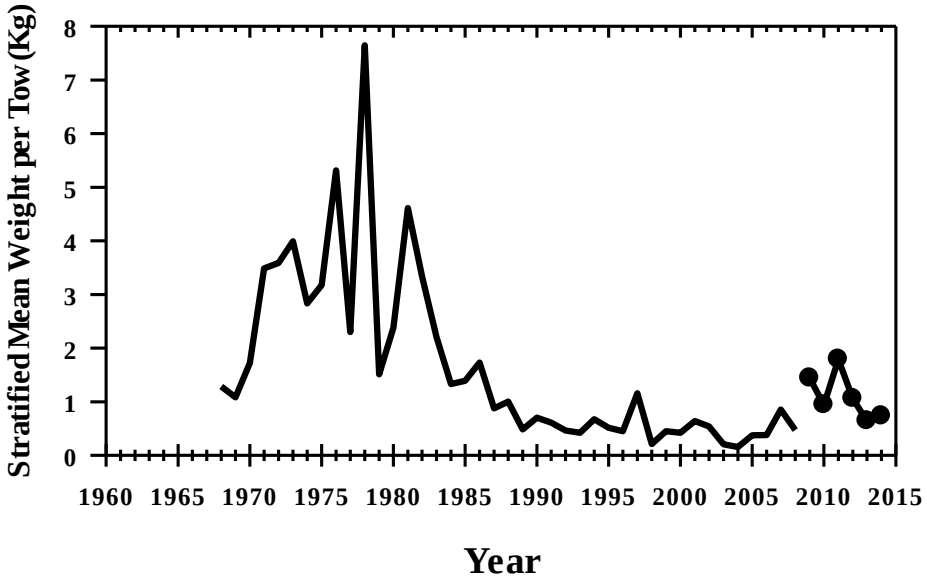

Figure 21. NEFSC spring bottom trawl survey biomass indices for southern red hake.

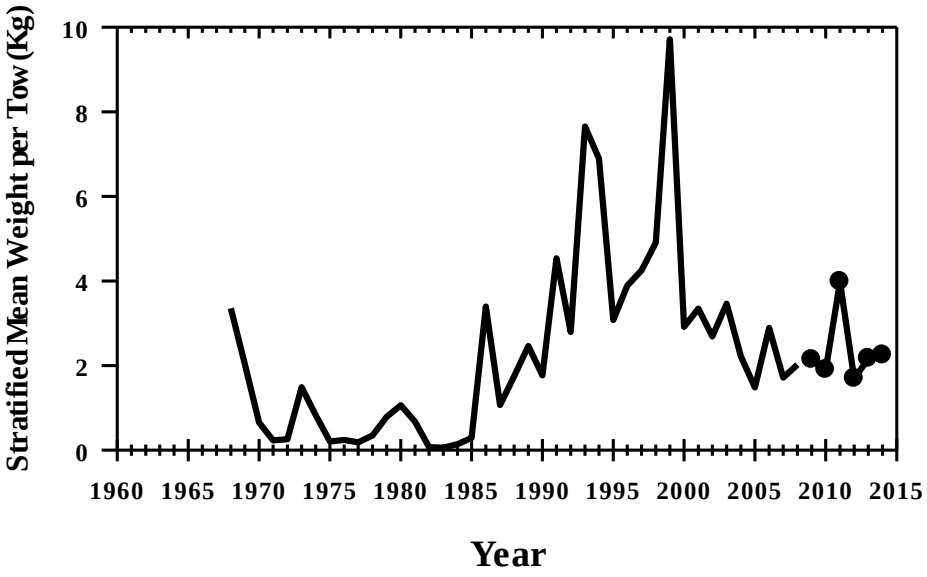

Figure 22. NEFSC spring bottom trawl survey biomass indices for Atlantic herring.

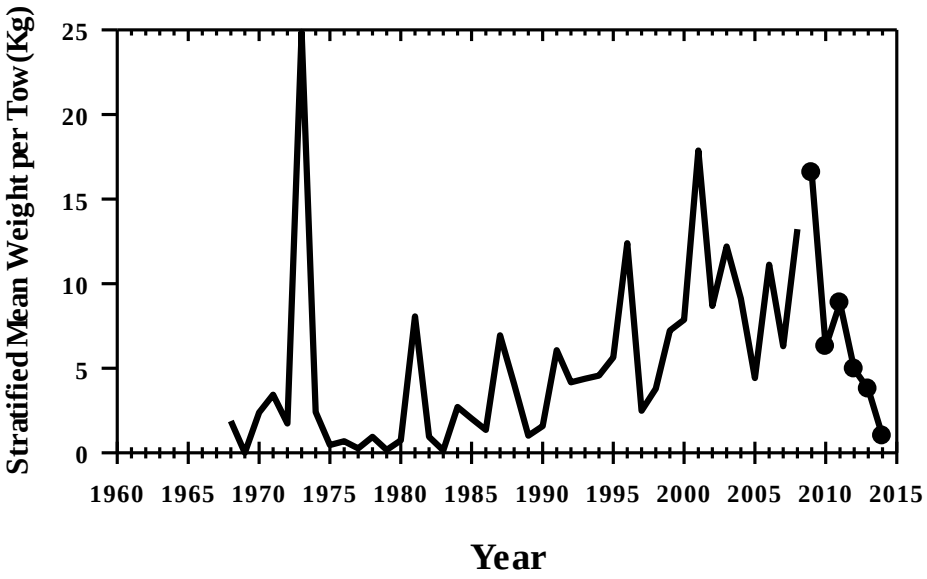

Figure 23. NEFSC spring bottom trawl survey biomass indices for Atlantic mackerel.

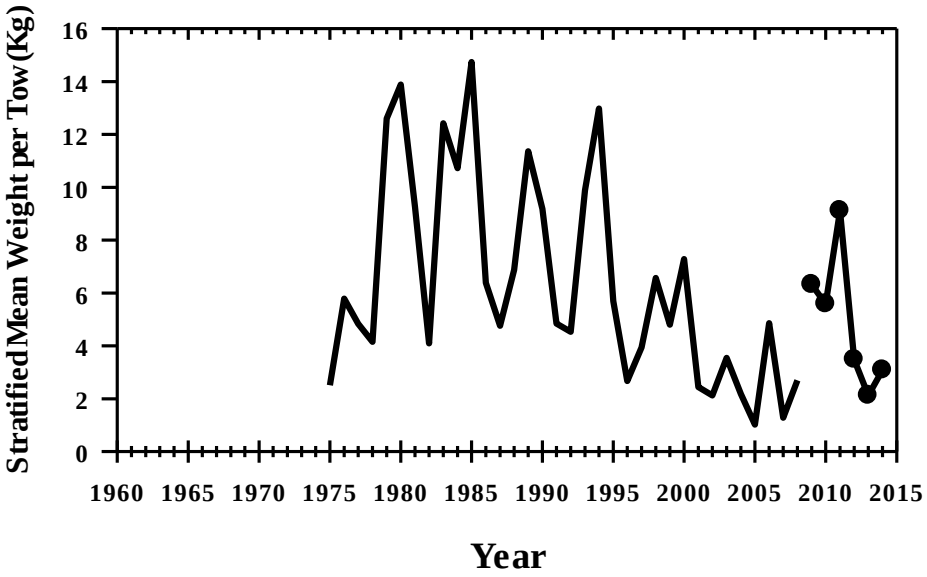

Figure 24. NEFSC autumn bottom trawl survey biomass indices for butterfish.

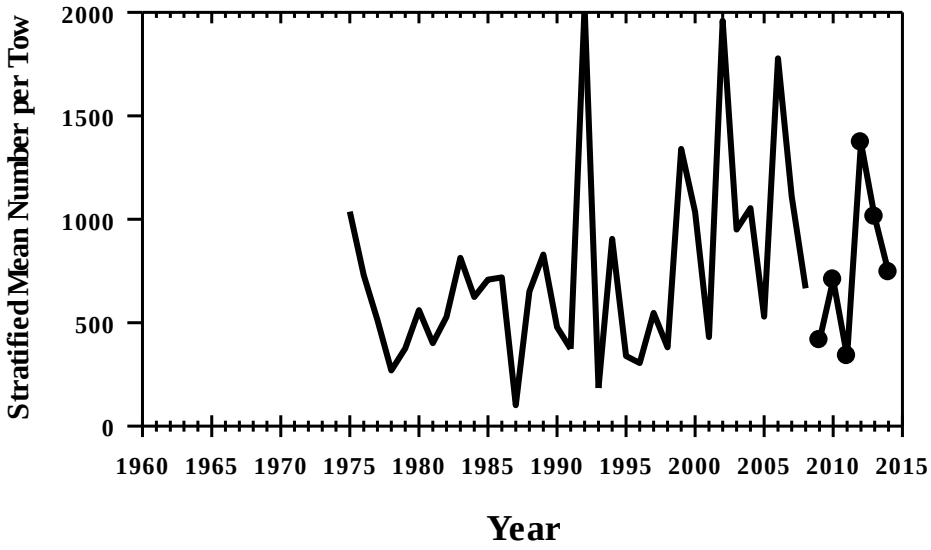

Figure 25. NEFSC autumn bottom trawl survey abundance indices for longfin inshore squid.

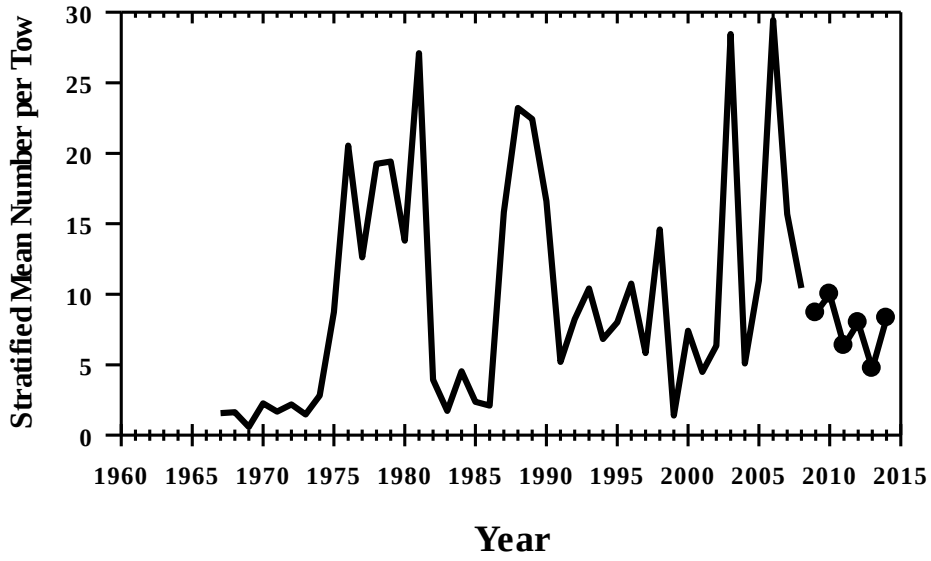

Figure 26. NEFSC autumn bottom trawl survey abundance indices for northern shortfin squid.

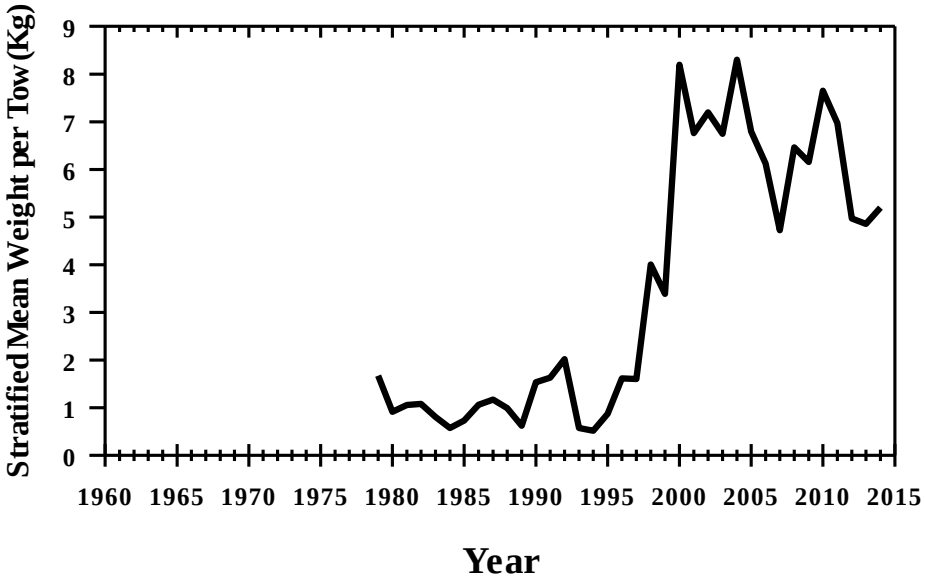

Figure 27. NEFSC scallop survey biomass indices for Georges Bank sea scallops.

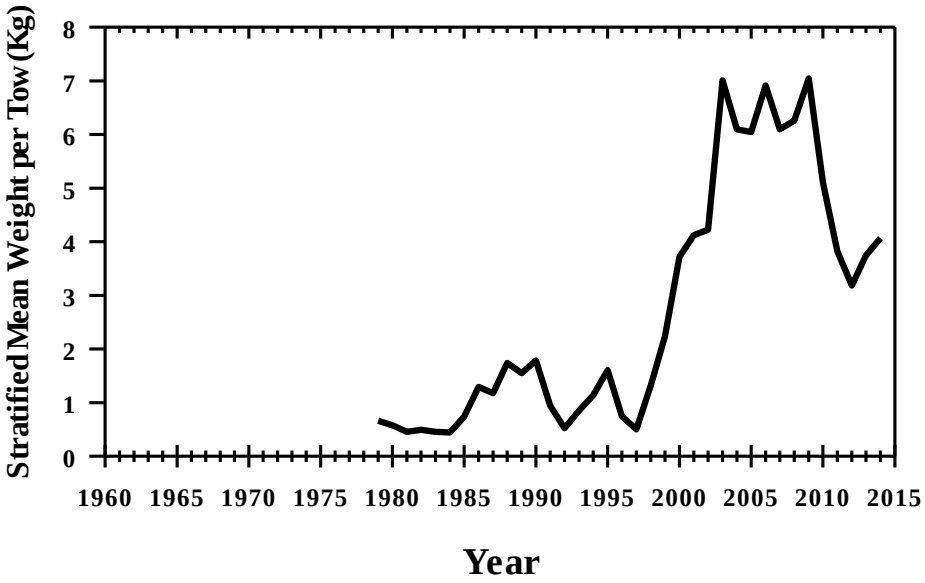

Figure 28. NEFSC scallop survey biomass indices for Mid-Atlantic Bight sea scallops.

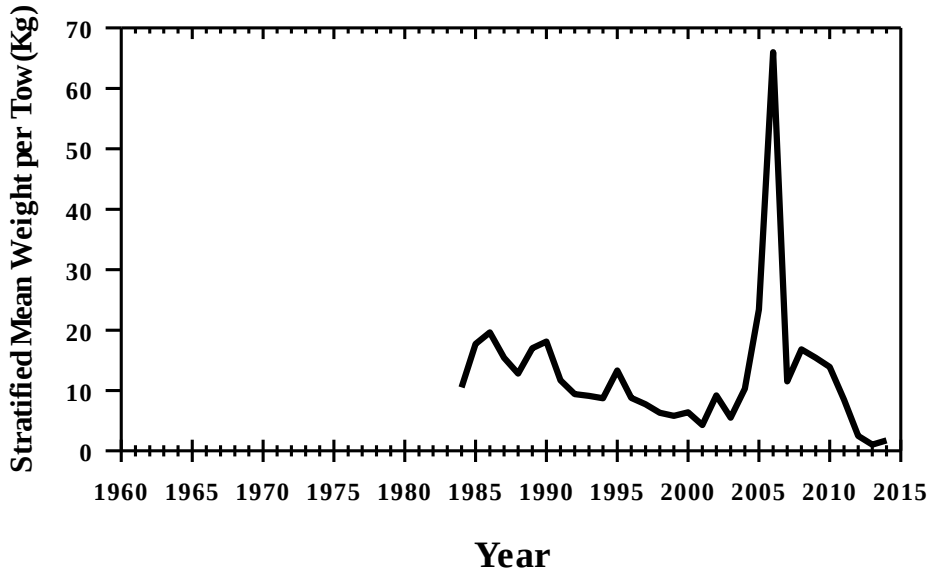

Figure 29. ASMFC summer shrimp survey biomass indices for northern shrimp.

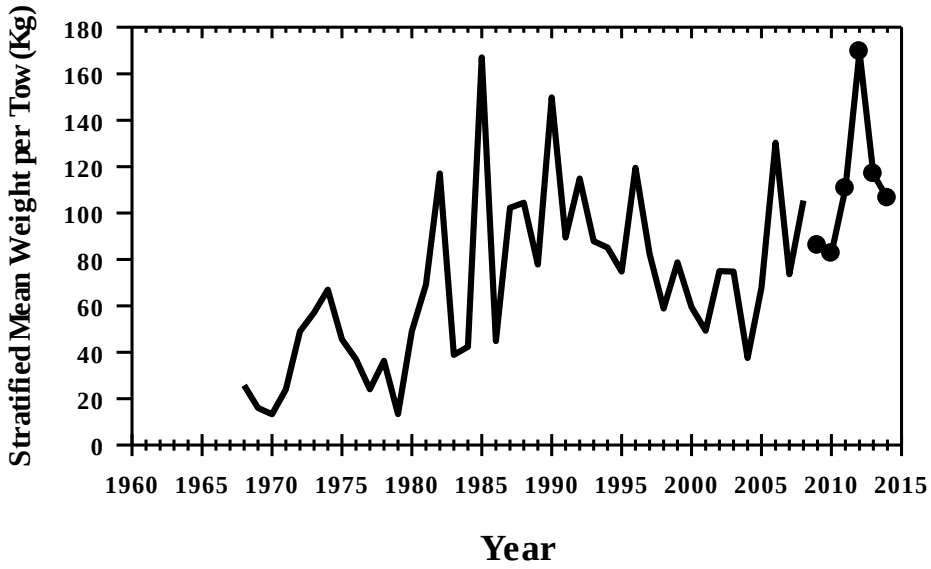

Figure 30. NEFSC spring bottom trawl survey biomass indices for spiny dogfish.

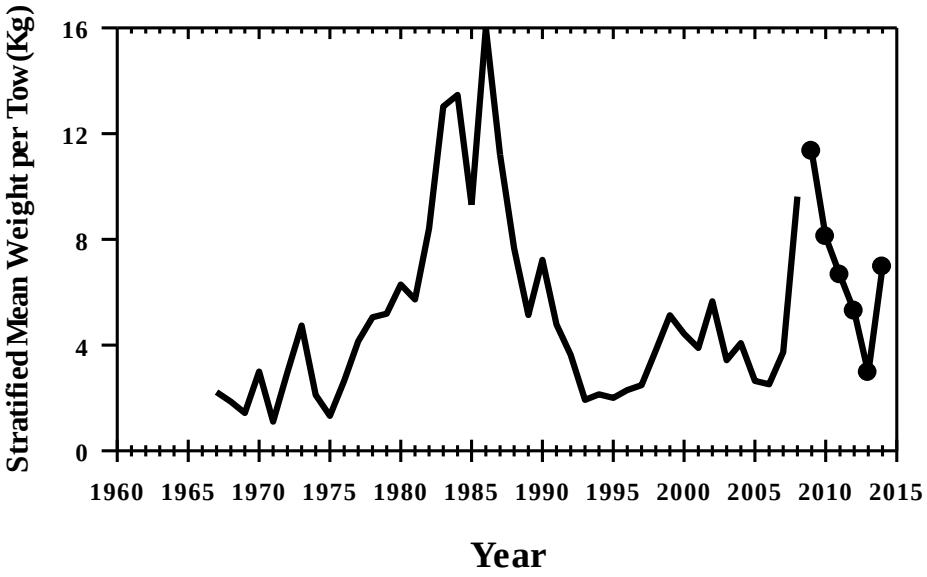

Figure 31. NEFSC autumn bottom trawl survey biomass indices for winter skate.

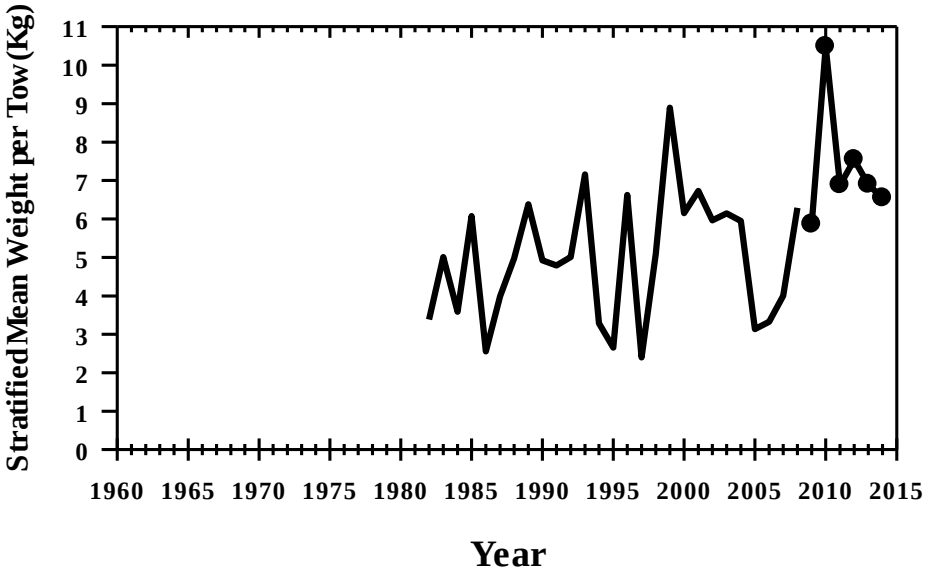

Figure 32. NEFSC spring bottom trawl survey biomass indices for little skate.

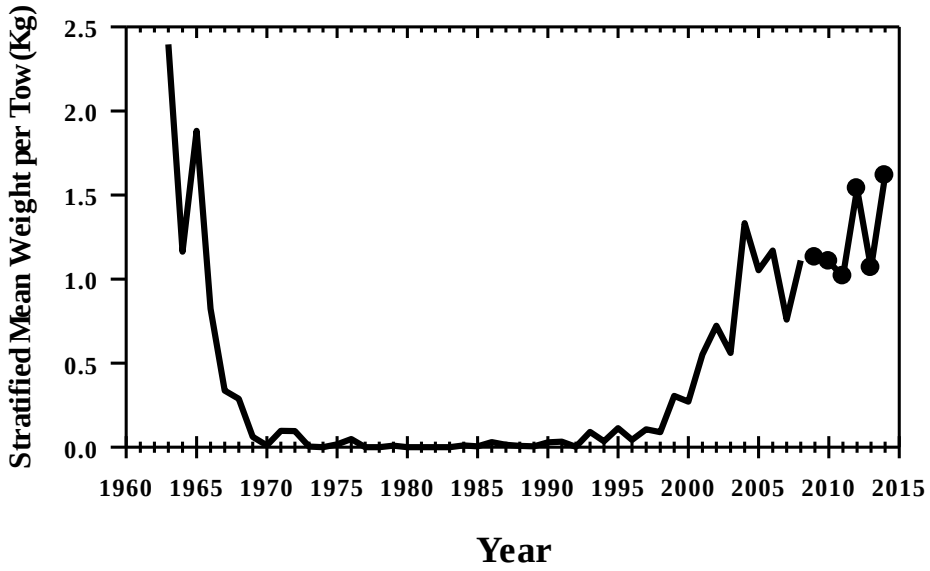

Figure 33. NEFSC autumn bottom trawl survey biomass indices for barndoor skate.

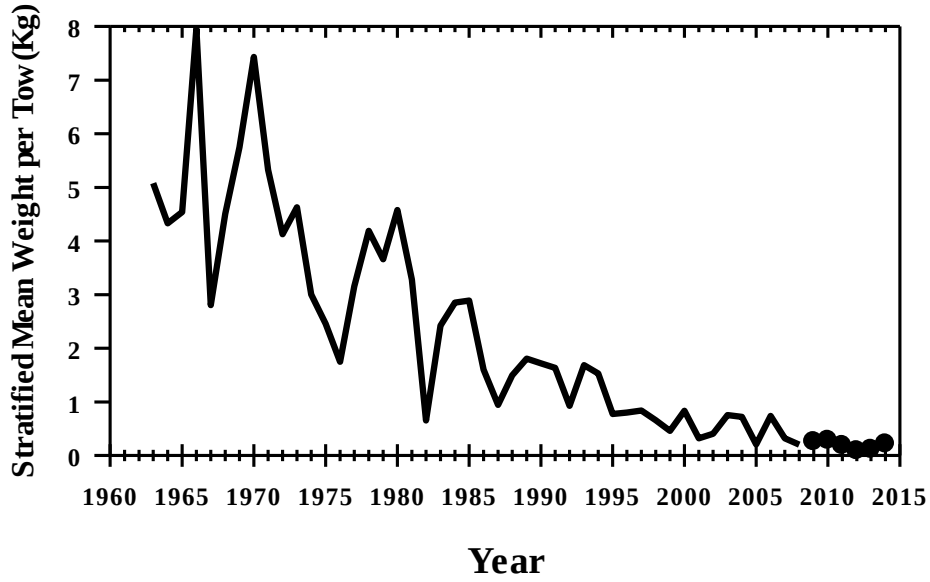

Figure 34. NEFSC autumn bottom trawl survey biomass indices for thorny skate.

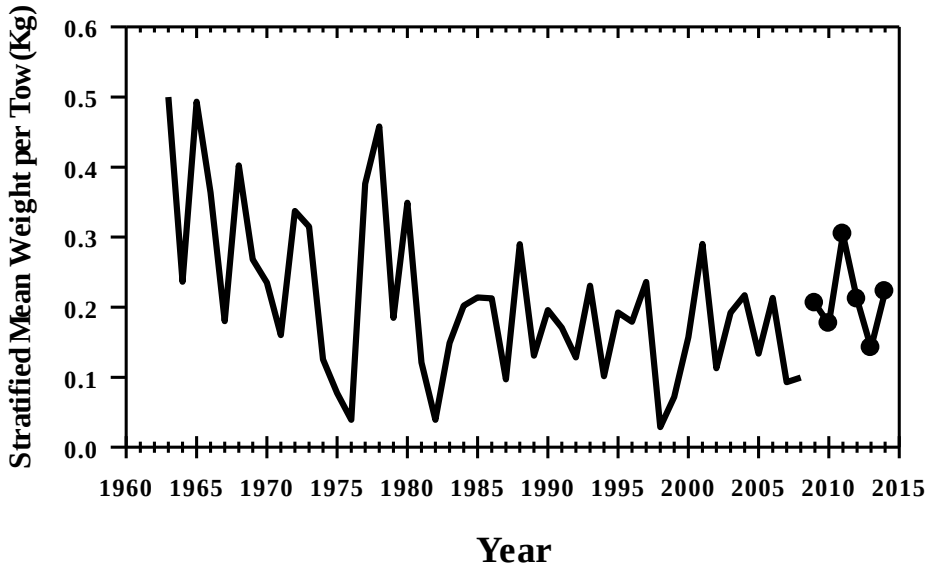

Figure 35. NEFSC autumn bottom trawl survey biomass indices for smooth skate.

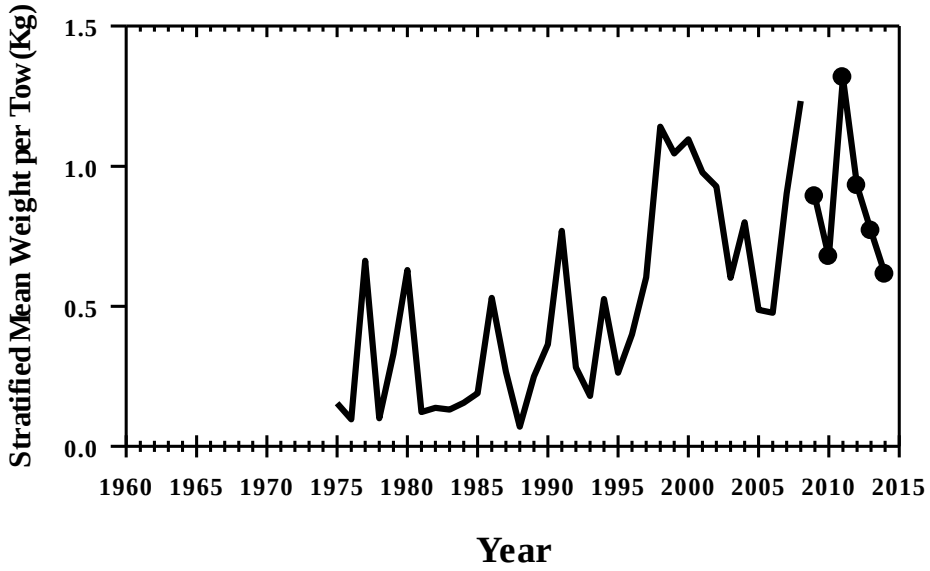

Figure 36. NEFSC autumn bottom trawl survey biomass indices for clearnose skate.

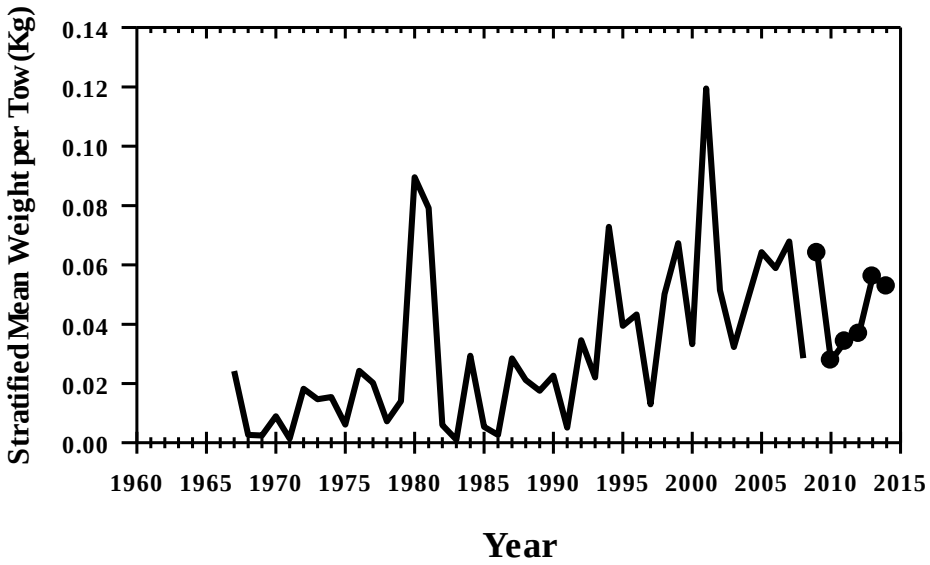

Figure 37. NEFSC autumn bottom trawl survey biomass indices for rosette skate.