Northwest Atlantic Fisheries Organization

Serial No. N5652 **NAFO SCS Doc. 09/18**

SCIENTIFIC COUNCIL MEETING - JUNE 2009

United States Research Report for 2008

by

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

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

Revised sampling and reporting protocols were implemented in the Northeast Region in 1994 and then again revised in 2004. Auditing and allocation procedures have continued to be used to prorate total reported landings by species among areas. However, these procedures are subject to change and therefore, the landings by area are still considered to be provisional. Auditing and allocation procedures are expected to be finalized in 2008.

1. Atlantic Cod

USA commercial landings of Atlantic cod (*Gadus morhua*) from Subareas 5&6 in 2008 were 8,645 mt, a 13% increase from 2007 landings of 7,679 mt and a 51% increase from the 5,723 mt landed in 2006.

USA cod landings from the Gulf of Maine (Div. 5Y) in 2008 were 5,439 mt, a 36% increase from 3,986 mt landed in 2007. Although discards remain a source of substantial additional mortality on this stock due to the imposition of relatively low trip limits beginning in 1999, discards declined after 2003 coincident with a relaxation of the trip limit. Northeast Fisheries Science Center (NEFSC) research vessel survey biomass indices gradually increased through 2001 following the 1993 record low. The sharp increase in the autumn 2002 index cannot be explained by the dynamics of the stock, and was largely driven by an extremely large catch at one station. Since 2000, the autumn survey biomass index has remained slightly above the low values of the 1990s (Figure 1).

USA cod landings from Georges Bank (Div. 5Z and SA 6) in 2008 were 3,206 mt, a 13% decrease from 3,693 mt landed in 2007. The NEFSC research vessel survey biomass indices have remained near record-low levels during 1991-2008, with the exception of an increase in the 2002 index, due primarily to a large catch at one station, and an increase in the 2004 index as a result of three large tows in three separate strata. The index increased in 2008 but remains among the record low values observed since 1991 (Figure 2).

2. Haddock

United States haddock (*Melanogrammus aeglefinus*) commercial landings increased 75% from 3,631 mt in 2007 to 6,352 mt in 2008. Georges Bank (Div. 5Z) haddock landings increased 95% from 2,938 mt in 2007 to 5,744 mt in 2008. Gulf of Maine (Div. 5Y) haddock landings decreased by 17% between 2007 and 2008 from 689 mt to 575 mt. Landings from both stocks are below historical levels.

Research vessel survey biomass indices decreased in 2008 for the Gulf of Maine and Georges Bank stocks (Figures 3 and 4). Stock biomass of Georges Bank haddock had increased sharply in 2004 due to the exceptional 2003 year class, then fluctuated around 40 kg/tow through 2007. Georges Bank stock biomass in 2008 dropped to about 18 kg/tow as the 2003 year class has decreased due to natural and fishing mortality. Gulf of Maine stock biomass has decreased from a recent high in 2000 as the strong 1998 year class has experienced both natural and fishing mortality.

3. Redfish

USA landings of Acadian redfish (*Sebastes fasciatus*) increased by 51% from 787 mt in 2007 to 1,190 mt in 2008. Research vessel survey biomass indices have increased since 1996 (Figure 5) and are currently comparable to the levels in the 1960s. The initial increase in abundance first detected in 1996 was due to improved survival of fish from the 1991 and 1992 year classes. By 2004, the population age structure had broadened to include abundant year classes from 1992 through 2000 (ages 4 through 12). Stock biomass has remained high due to growth and survival of these year classes, as well as the 1984, 1985 and 1986 cohorts. Survey biomass indices since 2003 are among the highest observed in the survey series.

4. Pollock (4VWX + 5 stock)

USA landings of pollock (*Pollachius virens*) increased by 38% from 8,371 mt in 2007 to 9,964 mt in 2008. Research vessel survey indices have reflected a moderate increase in pollock biomass in Subarea 5 from the mid-1990s through 2005 (Figure 6). In 2006, 2007 and 2008, however, the biomass indices declined sharply, to values last observed in the late 1990s.

5. White Hake

USA landings of white hake (*Urophycis tenuis*) decreased by 13% from 1,528 mt in 2007 to 1,324 mt in 2008. 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 subsequently declined through 2005 and increased due to another year class through 2008 (Figure 7).

6. Yellowtail Flounder

USA landings of yellowtail flounder (*Limanda ferruginea*) decreased 5% from 1,756 mt in 2007 to 1,668 mt in 2008. Research vessel survey indices suggest that the Georges Bank stock (Div. 5Z, E of 69W) is at a moderate biomass level, while the Southern New England-Mid Atlantic stock (Div. 5Z W of 69W and SA 6) remains low (Figures 8 and 9).

7. Other Flounders

USA commercial landings of flounders (other than yellowtail flounder) from Subareas 3-6 in 2008 totaled 8,600 mt, 9% lower than in 2007. Summer flounder (*Paralichthys dentatus*) (47%), winter flounder (*Pseudopleuronectes americanus*) (27%), witch flounder (*Glyptocephalus cynoglossus*) (12%), American plaice (*Hippoglossoides platessoides*) (13%), and windowpane flounder (*Scophthalmus aquosus*) (1%) accounted for virtually all of the 'other flounder' landings in 2008. Compared to 2007, commercial landings in 2008 were higher for American plaice (10%) but lower for windowpane (-40%), winter flounder (-13%), summer flounder (-10%) and witch flounder (-7%). Research vessel survey indices in 2008 increased for American plaice, witch flounder, winter flounder and windowpane flounder and decreased for summer flounder (Figures 10-14).

8. Silver hake

USA landings of silver hake (*Merluccius bilinearis*) decreased by 7% from 6,359 mt in 2007 to 5,902 mt in 2008. Research vessel survey biomass indices for the Gulf of Maine - Northern Georges Bank stock varied without trend between 1985 and 1997, sharply increased in 1998 and have since continued to decline (Figure 15). Survey indices for the Southern Georges Bank - Mid-Atlantic stock declined between 1989

and 1996, remained very low during 1997-2000, and have since increased (Figure 16).

9. Red Hake

USA landings of red hake (*Urophycis chuss*) increased 4% from 511 mt in 2007 to 530 mt in 2008. Landings have remained low since 1980. Research vessel survey biomass indices for the Gulf of Maine - Northern Georges Bank stock increased steadily after the early 1970s, markedly declined in 2004-2005, and have since increased slightly (Figure 17). Indices for the Southern Georges Bank - Mid-Atlantic stock, however, continue to remain low (Figure 18) despite low landings.

10. Atlantic Herring

Total USA landings of Atlantic herring (*Clupea harengus*) increased 1% from 81,359 mt in 2007 to 82,578 mt in 2008. The spring survey index markedly increased in the 1990s, sharply declined in 2000, and has since ranged between 1.5-3.0 kg/tow (Figure 19). The spring index for 2008 equaled 1.7 kg/tow. Spawning biomass of the coastal stock complex has increased since 1982 and is currently stable at about 1 million mt. Stock size has increased due to both strong recruitment and reduced fishing mortality on both adult and juvenile herring

11. Atlantic Mackerel

USA commercial landings of Atlantic mackerel (*Scomber scombrus*) decreased 15% from 25,547 mt in 2007 to 21,728 mt in 2008. Recreational catch declined 22% from 884 mt in 2007 to 691 mt in 2008. Spring survey indices increased steadily during the 1990s and have averaged 8.7 kg/tow during 2000-2007 (Figure 20). The 2008 spring survey index was 11.6 kg/tow. Spawning stock biomass in 2005 was estimated at 2.3 million mt. Stock rebuilding since 1981 has resulted from very low fishing mortality rates and the recruitment of several good year classes (1982, 1999, and 2003).

12. Butterfish

USA landings of butterfish (*Peprilus triacanthus*) decreased 33% from 674 mt in 2007 to 451 mt in 2008. Research vessel survey biomass indices increased during the late 1970s, fluctuated during the 1980s, were below the long-term average during 2001-2005, increased in 2006, and declined to the series low of 0.732 in 2007 (Figure 21).

13. Squids

USA landings of northern shortfin squid (*Illex illecebrosus*) during 2008 totaled 15,900 mt, 76% higher than in 2007 (9,022 mt). The NEFSC autumn survey relative abundance index reached a record high value in 2006 but then declined thereafter to a level slightly above the time series average in 2008 (Figure 22)

USA landings of longfin inshore squid (*Loligo pealeii*) in 2008 totaled 11,360 mt, slightly lower (8%) than in 2007 (12,342 mt). The NEFSC autumn survey abundance index reached a record high in 2006 but then declined thereafter to a level slightly below the time series average in 2008 (Figure 23).

14. Sea Scallops

USA sea scallop (*Placopecten magellanicus*) landings in 2008 were 24,169 mt (meats), slightly less than 2007, but still over twice the long-term (1957-2007) average. About 28% (6,682 mt) of the 2008 landings was harvested from Georges Bank, whereas 68% (17,346 mt) was from the Mid-Atlantic. Since 2000, a majority of the landings have come from the Mid-Atlantic region in every year except 2006. By contrast, during 1957-1999, most USA sea scallop landings were harvested from Georges Bank.

Research vessel survey indices in 2008 showed modest increases in sea scallop biomass on both Georges Bank and the Mid-Atlantic, and the biomasses in both regions remained high by historical standards (Figures 24 and 25). Most of the scallop biomass on Georges Bank is in the groundfish closed areas, which have also been closed to scallop fishing for most of the time since 1994. In the Mid-Atlantic region, most

of the scallop biomass is in a rotational area off of New Jersey and Delaware (the Elephant Trunk area), which was closed in 2004 and reopened to sea scallop fishing in 2007. Around 10,000 mt (meats) was harvested from this area in 2008. Recruitment in 2008 was above average both on Georges Bank and in the Mid-Atlantic. This is the first year since 2001 for which strong recruitment was observed on Georges Bank. Recruitment in the Mid-Atlantic was the second highest in the survey time series (since 1979).

15. Small Elasmobranchs

USA landings of spiny dogfish (*Squalus acanthias*) increased by 9% from 3,503 mt in 2007 to 3,812 mt in 2008. Survey indices, which are highly variable, generally declined from the early 1990s through 2005 but increased sharply in 2006 and remained high through 2008 (Figure 26).

USA landings of skates (most still landed as unclassified) decreased by 4% between 2007 and 2008 from 19,085 mt to 18,326 mt. The landings are sold as wings for human consumption and as bait for the lobster fishery. Research survey biomass indices for winter skate (*Leucoraja ocellata*) peaked in the mid-1980s (Figure 27) and subsequently declined possibly due to an increase in the directed fishery in the 1990s. During the 1990s, the indices were stable at an intermediate level, but have declined until 2008 when the index increased substantially. Little skate (*Leucoraja erinacea*) survey indices have generally fluctuated without trend (Figure 28). Survey indices for barndoor skate (*Dipturus laevis*) declined precipitously in the mid-1960s, remained very low through the late-1980s, and subsequently increased to about the same level as in the mid-1960s (Figure 29). Thorny skate (*Amblyraja radiata*) survey indices have declined over the entire time series and are currently near record lows (Figure 30). Survey indices for smooth skate (*Malacoraja senta*) are highly variable but exhibited a decline in the early part of the time series and have been generally stable for the last 20 years (Figure 31). Indices for both clearnose skate (*Raja eglanteria*) and rosette skate (*Leucoraja garmani*) generally increased over the time series although the indices for clearnose skate declined between 2001 and 2006 with a sharp increase in 2008 to the highest value in the time series (Figures 32 and 33).

B. Special Research Studies

1. Environmental Studies

a) Hydrographic Studies

A total of 1841 CTD (conductivity, temperature, depth) profiles were collected on Northeast Fisheries Science Center (NEFSC) cruises during 2008. Of these, 1811 were obtained in NAFO Subareas 4, 5, and 6. The CTD data were processed, edited and 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.

b) Plankton Studies

During 2008, zooplankton community distribution and abundance were monitored using 661 bongo net tows taken on five surveys. Each survey covered all or part of the continental shelf region from Cape Hatteras northeastward through the Gulf of Maine. The Ship Of Opportunity Program (SOOP) completed 7 transects across the Gulf of Maine from Cape Sable, NS to Boston, and 12 transects across the Mid-Atlantic Bight from New York to the Gulf Stream.

c) Benthic Studies

The Milford Laboratory is engaged in a cooperative research project with the East Coast Shellfish Growers, their Research Institute, and commercial shellfish growers to investigate interactions between shellfish cultivation and habitat. In reviewing topical literature, we have assembled over 300 relevant papers and are preparing a synthesis document. Farming shellfish involves initial seabed disturbance, however bivalves offer beneficial ecological services as they grow. A field experiment is in progress to compare benthic biodiversity, abundance of macrofauna, and sediment biogeochemistry in areas where oysters or clams

have been harvested, as well as in unharvested control areas. The study is focused on measuring ecological recovery over the course of cultivation cycles. Results of this study should shed new light on how shellfish aquaculture affects habitat ecology.

The NEFSC's James J. Howard and Woods Hole Laboratories, U. S. Geological Service (USGS), and several collaborating academic institutions (see below) conducted an extensive field program to develop methods for mapping, characterizing and developing hypotheses regarding benthic habitats and their macrobenthic and demersal communities during 2008.

A 12 day cruise was conducted during January, 2008 for the purposes of training students in the NOAA Living Marine Resources Cooperative Science Center (LMRCSC) program and conducting joint research projects with NMFS and LMRCSC faculty from the University of Maryland Eastern Shore. Scientific findings included the following:

- Sampling the outer continental shelf and slope around Hudson Canyon has revealed an emerging pattern in which a background of resident species appear consistently in particular habitats year-to-year while others, largely seasonal migrants, do not appear to make use of those habitats in a consistent manner, even in the same season. Catch, hydrographic, sedimentological, and visual (photo and video) data are being analyzed ashore to elucidate this pattern and understand what conditions cause fisheries resource species to behave in this way.
- Dense patches of deepwater cup corals (*Dasmosmilia lymani*), first observed in 2004, were again sampled. These continue to persist around the rim of Hudson Canyon despite moderate commercial trawling activity, suggesting unexpectedly high resilience to disturbance.
- Comparisons were made between catches from side-by-side tows with an 11 m otter trawl (Yankee 36 standard NEFSC survey trawl) and 2 m beam trawl at 18 sites on the continental shelf between New Jersey and North Carolina for purposes of developing better sampling methods for assessing macrobenthic/demersal community structure and biodiversity. Of 123 total species captured, 71 (58%) were caught exclusively in the beam trawl, 32 (26%) were caught by both methods, and 20 (16%) were caught exclusively with the Yankee 36. Biodiversity is greatly underestimated by the use of either method alone, but especially if only Yankee 36 is used. Further, regarding species caught in both trawl types, beam trawls yielded small size classes not captured by Yankee 36 and provided higher overall estimates of density per unit bottom area for many species. Work with multiple sampling methods for better definition of ecological properties continues.

A 17 day cruise was conducted during June, 2008 in order to explore shelf habitats on the mid Atlantic shelf, including areas in the Inner New York Bight, and Maryland offshore reefs.

- The Kongsberg ME70 fisheries research multibeam sonar was employed for the first time for extended bottom habitat mapping. Approximately 157 hours were devoted to mapping a total area of about 90 km^2. The limitations of this system in this application as presently configured and operated became evident. Based on this experience, a detailed internal report describing the problems with this application and suggesting remedies was generated in early 2009.
- Single beam sonar data collected simultaneously with multibeam revealed submarine landscapes not previously mapped at medium resolution. Previously described patch reefs harboring large aggregations of black sea bass and other structure-seeking fishes on the shelf off Ocean City, MD were found to be associated with rock and/or clay outcrops and gravel deposits in elongated bathymetric depressions, likely river valleys created during the Pleistocene low sea level stand.
- 145 beam trawl tows were made to investigate the fauna of various habitats in the NY Bight and Maryland reefs area. Comparison of areas suggests that local hydrographic and topographic differences (i.e. between Long Island and New Jersey within the NYB) may be more important that large latitudinal separations (i.e. between Long Island and Maryland). Comparisons between habitats and the roles of hydrographic, geological, and ecological variables in determining habitat use by resource species is being performed with this data.

A 14 day cruise was conducted in July, 2009 order to explore shelf habitats on the northern Georges Bank within Closed Area II in collaboration with USGS and the Massachusetts Institute of Technology.

- Multibeam and single beam sonars were employed for extended bottom habitat mapping. Approximately 85 hours were devoted to mapping a total area of about 110 km^2. These revealed topographic details not previously known, including a strip of rough terrain along the northern rim that supports a dense epifauna and appears to functions as an important habitat for adult cod and haddock. This habitat is entirely within the Closed Area II HAPC on the U.S. side of the Hague Line and probably represents a Pleistocene glacial deposit. Dredge and video samples taken in 2007 demonstrated a particularly diverse epifauna with a high biomass in this area.
- Operations were conducted with the MIT Sea Grant AUV Odyssey IV in order to test its operation in offshore waters and its utility as a platform for extending the search for infestation of the invasive colonial tunicate *Didemnum vexillum* beyond the limited capabilities of current optical technologies. Didson imaging sonar was not adequate for reliable detection and assessment of the tunicate as hoped; bottom photos were much better. Nevertheless, with some improvements, this AUV design could prove valuable for fisheries habitat studies for which accurate near bottom navigation is required.

A 6 day cruise was conducted in early August, 2008 in order to investigate both benthic and pelagic habitat conditions in Hudson Canyon, off New Jersey, a local fishing "hot spot" for both commercial and recreational fisheries and a feature being considered for designation as a Habitat Area of Particular Concern (HAPC). High resolution mapping of portions of the canyon was performed using AUV-mounted multibeam sonar. Near-synoptic CTD profiles were collected for the entire shelf and adjacent upper slope portions of the canyon head region, including water samples for methane and ocean acidification analyses.

- Bottom mapping was accomplished for approximately 45 km^2 of Hudson Canyon at very high resolution with the use of the National Institute of Undersea Science and Technology (NIUST) AUV "Eagle Ray" equipped with multibeam sonar.
- Participating investigators hailed from NEFSC, the University of Southern Mississippi, Rutgers University, Richard Stockton University, and the State University of New York at Stony Brook.
- Multibeam imagery from Eagle Ray revealed heavily dissected, steeply sloped topography on the east wall of Hudson Canyon not clearly visible in any previous mapping. This kind of bottom is likely to support Vulnerable Marine Ecosystems (VMEs) associated with deepwater coral, sponge, and tilefish pueblo village habitats. The presence and location of such systems are necessary for any HAPC designation. The detailed mapping provides precise locations to conduct efficient, targeted searches by visual means, which will be undertaken in 2009.
- A CTD/water sampling grid covering most of the shelf and upper slope portion of the canyon demonstrated strong and complex vertical and horizontal gradients in temperature and salinity that varied appreciably across both space and time. Based on analogous nearshore investigations, this dynamic pelagic layering pattern should have strong implications for local larval dispersal, vertical migration patterns, and the redistribution of fisheries species and the food resources on which they depend.
- Water samples for locating sources of deepwater dissolved methane concentrations were taken over the upper slope portion of the canyon. Results suggest the presence of canyon methane seeps, which may in turn support chemosynthetic communities. Both the presence of such seeps and any associated communities await further sampling and visual confirmation.
- Water samples were also utilized to develop onboard techniques in house (within NEFSC) for measuring ocean acidification.

A 14 day cruise was conducted during late August, 2009 in cooperation with USGS and University of Rhode Island in order to investigate cod-haddock-sea scallop habitat and the relationship of the invasive colonial tunicate *Didemnum vexillum* to that habitat and its fisheries resources, including investigation of areas of known infestation since 2002, areas of newly-discovered infestation, and areas not yet colonized by the tunicate on both sides of the U.S.-Canadian border and both inside and outside of areas closed to bottom fishing in the U.S.

- Sampling methods utilized on this cruise included transects with the USGS Seaboss drift video/photo vehicle, fish sampling for species composition and trophic (gut content) analysis with

the NEFSC 4-seam otter trawl, epifaunal sampling with a naturalists dredge, hydrographic profiling and water sampling (the latter for ocean acidification analysis) with a CTD/Niksin bottle combination, and bottom habitat mapping with *Bigelow*'s ME70 multibeam and EK60 single beam sonars.

- The presence of *D. vexillum* in areas along the northeast peak of the Bank in both fished (area 18) and closed (area 19, within Closed Area II) areas in the U.S. was confirmed, although the degree of coverage and thickness of colonies was somewhat less than in 2007. The extent of these areas has not expanded since 2006, probably due to limitations by sediment type and temperature. The tunicate's presence in Closed Area I, discovered in 2006, was reconfirmed. The tunicate was not found in habitats on the Bank's northern rim in the U.S., nor anywhere on the Canadian side of Georges, neither near the rim nor further into the Bank. It is thought that temperature regimes too cool to allow sexual reproduction of *D. vexillum* have prevented these areas from being colonized.
- As in previous years, elevated numbers of two polychaete species were associated with *D. vexillum*, and both *D. vexillum* and *D. albidum* were found to constitute large portions of the stomach contents of some winter flounder individuals where the tunicate was abundant.
- Additional mapping, dredge, trawl, and video/photo sampling was performed in the rugged rim area (described in the July cruise description above) along the northern edge of Georges Bank and a similar, noncontiguous area on the Canadian side of Georges Bank.

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

In 2008 we revisited and mapped this remarkable habitat using video and photographic sampling devices and the multibeam sonar mapping system of the new NOAA fisheries research vessel *H.B. Bigelow*. We found that the pristine seabed is pebbles, cobbles, and piles of boulders deposited by melting glaciers during the last period of glaciation. This rough seabed not only provides hard substrate for benthic species to grow on but also has protected the area from fishing gear which gets tangled and caught in areas of high relief. We have observed rusting fishing cables that are evidence of past efforts to fish the area. The pristine area is 51 sq km in size. The gravel seabed surrounding it does not exhibit boulder piles and thus had not been protected from fishing prior to the closing of 1994. Compared to the pristine area, it is relatively barren of benthic fauna and appears not to have recovered during 14 years of closure, despite its location adjacent to the unaffected area. As far as we know, the newly-discovered undisturbed area is unique on the U.S. part of Georges Bank and serves an important role for the fishery and as a research site for studies on the processes of habitat recovery. It is located only 10 nm northeast of gravel habitats colonized by *Didemnum vexillum* and requires monitoring to assess the impact of the tunicate should it invade the area.

This research is a basis for understanding the role of undisturbed gravel habitats in sustaining healthy fish populations and for determining if recovery of habitats that have been trawled for over 100 years is possible.

2. Biological Studies

a) Fish Species

Flatfishes: We are currently analyzing the relative roles of the environment and of parentage to offspring quality and viability from an experimental study on winter flounder, *Pseudopleuronectes americanus*.

Such information is important for a thorough understanding of recruitment patterns as well as the aquacultural potential of a species. The data are derived from an experiment that was designed to evaluate the relative contributions of paternal, maternal, and thermal contributions to early life-history traits of their offspring. Responses were scored from embryonic development through larval life and into juvenile life-stage, culminating with gender expression. Preliminary analyses of these data show the relative ranking of families (sib-groups) in regards to their growth and developmental rates to change with the environment. Such environmental dependency affects the notion of preferred or optimal phenotype in nature or aquaculture because such a determination will depend on the environmental context.

Gadids: Field and laboratory research continues on Atlantic tomcod, *Microgadus tomcod*, a locally abundant inshore gadid of the Northeastern USA and Eastern Canada. Tomcod has a 1-yr life cycle, is an important forage fish, and serves as a sentry of habitat and fish community health in the Hudson River Estuary (New York / New Jersey, USA). Two concurrent projects on tomcod are underway that address ecological and toxicological themes. Regarding the ecological theme, estimates are being obtained for: 1) maternal effects on offspring quality; 2) ontogenetic rates of eggs, larvae, and juveniles; 3) time of settlement, behavioral transitions with respect to habitat structure, and movement of juveniles in nature; and 4) risk of predation. Regarding the toxicological theme, three source populations – Hudson River, Shinnecock Bay (Long Island, New York) and Miramichi River (New Brunswick, Canada) that differ in contaminant histories are being compared with respect to: 1) uptake and depuration rates of dioxin and locally occurring (Hudson River) congeners of PCBs; 2) sublethal toxic responses to graded doses of local PCBs congeners using captive (F_1 and F_2) tomcod populations; and 3) interactions between environmental stressors, i.e., PCBs and high summer temperatures. The toxicological work in 2008-09 includes an assessment of the combined effects of PAHs and PCBs on ecologically relevant toxic endpoints. Collaborations in 2007-09 with colleagues at New York University and at University of Maryland Eastern Shore include evaluating the incidence of tumors in laboratory-reared F_1 juveniles exposed as embryos to combinations of PAHs and PCBs, and larvae / juveniles exposed to PCBs via contaminated brine shrimp as food. We recently completed the 13-mo grow out period and sacrificed the adults for body size size, gonad size, liver size, and preserved samples for histological evaluation of their livers and biochemical analyses of their ovaries with respect to their exposure history, We also continued an assessment of effects of nanoparticles on tomcod early life-stages in order to get a measure of effects of type and dose of commonly manufactured nanoparticles.

Weakfish: Field collections and laboratory processing are continuing in a recruitment study of weakfish, *Cynoscion regalis*. The thrust of this work is to 1) describe the demographic structure of spawners in the local system (Hudson River estuary and nearby coastal waters, New York / New Jersey); 2) investigate the pattern of mortality of young-of-the-year based on hatching dates and growth rates derived from otolith microstructure; and 3) evaluate whether differences in survival are related to maternal sources of variation in the timing spawning and the quality of eggs. Juvenile weakfish are being evaluated for evidence of selective mortality during their first season of growth.

Hudson River Estuary Ecosystem: Field and laboratory evaluations of patterns of abundances of the ichthyofauna of the Hudson River Estuary Ecosystem and processes that affect these abundances are ongoing. Regular (monthly) sampling of the estuary from April through October has been conducted since 1999. These data, along with others from earlier federal projects and with ongoing surveys by state and private concerns, are being analyzed for community-wide patterns in general, and the association between target species and habitat variables in particular.

During 2008, personnel from the Behavioral Ecology Branch, Ecosystems Processes Division, NEFSC, established two 1000 hectare seascapes south and west of the mouth of the Hudson River estuary in which to develop sampling approaches and to test gears. Sidescan sonar and bathymetry data indicate that both seascapes are composed of similar benthic habitats, including sand waves, crescentic dunes and gauconite marle reefs. However pelagic habitat characteristics driven by climate forcing differ substantially between the two seascapes. The seascape south of the Hudson-Raritan River Estuary consistently receives flows of water and nutrients derived from the estuary and is located in the area where episodes of low oxygen and phytoplankton blooms are known to occur. Flows into the eastern seascape are generally from the east, and poorer in nutrients except during periods when strong or persistent southerly winds cause estuarine plume

water to spin up along the southern coast of long island. Rapid and repeated transects conducted with ctd's and hydroacoustics across both seascapes in 2006 indicated that pelagic habitat structure defined by the number of density steps/acoustic layers is more complex in the southern seascape than in the eastern long island seascape. Differences in current flows across the two seascapes may also result in different sources of larvae and thus community structure despite similarities in benthic habitat structure. Our intent is to develop techniques and technologies to quantitatively sample and analyze the distribution and condition of early life history stages of fishes in these two seascapes with respect to benthic and pelagic characteristics. In 2008, demersal species were sampled with a camera sled fitted with CTD and oxygen sensors, and by a traditional fishing net. Time stamped video images of fish and habitat, real time data from sensors, and GPS data, will allow us to include habitat in our analysis of animal distribution patterns. Within these seascapes, we also conducted adaptive icthyoplankton sampling previously initiated in 2005 which used shipboard wireless access to real and near real time geographically referenced IOOS ocean imagery (HF radar, satellite) along with shipboard hydro-acoustic and CTD measurements to sample to species/stages of ichthyoplankon with respect to the 3-dimensional dynamic structure of the coastal pelagic environment. We believe that a fully developed approach will produce in-situ observations essential for behavioral parameterization of biophysical habitat connectivity models in the mid-Atlantic bight and the changes in connectivity that may result from changes in climate forcing. The approaches successfully developed in the pilot surveys will be fully implemented in broader scale processed- based surveys stratified on the basis of indicators identified in a concurrent analysis of existing historical data.

b) Resource Survey Cruises

During 2008, personnel from the Ecosystems Surveys Branch (ESB) staged, staffed and supported the spring and fall multispecies bottom trawl, spring and fall trawl calibration, and northern shrimp trawl surveys. Additional staff and gear support was provided for the sea scallop dredge, sea scallop gear comparison, surfclam/ocean quahog, Atlantic herring hydroacoustic, non-ESB and cooperative surveys for a total of 406 research and charter vessel sea days. NOAA scientific staff participated on a total of 3,528 staff sea days and volunteers contributed another 1,097 person sea days. ESB cruises occupied 2,845 stations in an area extending from Cape Hatteras, North Carolina to Nova Scotia including the Gulf of Maine. A total of 3,712,301 length measurements were taken from 406 species during these cruises. Ecosystem survey data currently is utilized as fishery independent abundance or biomass inputs for 48 single species stock assessments and several ecosystem dynamics modeling efforts.

Significant sampling effort was also expended to fulfill requests from 44 NOAA and University investigators for samples or observations made during the various survey cruises. These included 16,865 feeding ecology observations, 32,188 aging structures removed, and 28,211 samples or individual specimens collected to support additional shore based research.

During the spring and fall, the recently built and deployed FSV Henry B. Bigelow completed calibration and bottom trawl catchability comparisons with existing bottom trawl survey operations conducted aboard the RV Albatross IV. This effort generated in excess of 600 useable paired tows that will allow for evaluation of catchability for approximately 45 species of assessed finfish and invertebrates. After 46 years of service, the RV Albatross IV was retired from service on November 20, 2008.

c) Age and Growth

Approximately 85,000 age determinations for 14 species of finfish and shellfish were completed in 2008 by Woods Hole Laboratory staff in support of resource assessment analyses. In addition to Atlantic cod (10,826), haddock (10,259), and yellowtail flounder (8,218), 7,228 summer flounder, 10,889 scup, 19,027 winter flounder, and 7,494 American plaice were aged. Age determinations for Atlantic herring, Acadian redfish, witch flounder, Atlantic surf clam, black sea bass, butterfish, and Atlantic mackerel totaled 10,593.

Cod, haddock, and mackerel age structures were exchanged with age readers from Fisheries & Oceans Canada laboratories in a continuing effort to maintain comparability of age determinations between laboratories. The Woods Hole Laboratory continued a study with Fisheries & Oceans Canada (St. Andrews

Biological Station) and Maine's Department of Marine Resources to standardize ageing methodologies among agencies and institutions ageing Atlantic herring, and to examine generic herring ageing research issues.

Research projects continued in 2008 included: (1) a broad study to enumerate current fecundity levels of multiple groundfish species; (2) histological sampling to calibrate macroscopic gonad staging performed during research vessel survey cruises; (3) a study examining growth chronologies in Acadian redfish; and (4) an age validation study of Atlantic surfclams using sectioned chondrophores obtained from samples collected across the geographic range of the species. New projects initiated in 2008 included: (1) a study examining historical juvenile growth patterns for yellowtail flounder in the southern New England-Georges Bank region (NAFO Subareas 53 and 52); and (2) a study investigating the feasibility of measuring bioelectrical impedance (BIA) as a predictor of fish condition and reproductive potential.

d) Food Web Dynamics

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

Food habits samples were collected on the northeastern and Mid-Atlantic continental shelf during NEFSC spring and autumn surveys. Estimates of prey volume and composition were made at sea for selected species. During the 2008 spring and autumn surveys, 5,910 stomachs from 56 species, and 6,416 stomachs from 60 species were examined respectively. Diet sampling emphasized small pelagics, elasmobranchs, gadiformes, flatfishes, and lesser known species.

The 36 year time series (1973-2008) of food habits data collected during NEFSC bottom trawl surveys continued. The majority of the time series is now available for analysis, including data from over 600,000 stomach samples. The processing of the 2008 bottom trawl survey food habits data is scheduled for completion in 2009.

Staff published several papers and reports on a wide range of trophic ecology issues in the Northwest Atlantic ecosystem. Since trophic interactions are central to food web and ecosystem considerations, research continues with respect to fish production, fisheries reference points, system-wide productivity, and essential fish habitat.

e) Apex Predators Program

Apex Predators research focused on determining migration patterns, age and growth, feeding ecology, and reproductive biology of highly migratory species, particularly large Atlantic sharks. Members of the Cooperative Shark Tagging Program, involving over 7,000 volunteer recreational and commercial fishermen, scientists, and fisheries observers, continued to tag large coastal and pelagic sharks and provide information to define essential fish habitat for shark species in US waters in 2008. Information was received on 5,300 tagged and 425 recaptured fish bringing the total numbers tagged to 211,000 sharks of more than 50 species and 12,850 sharks recaptured of 33 species. The Guide to Sharks, Tunas, & Billfishes of the US Atlantic and Gulf of Mexico was reprinted and made available to sport and commercial fishermen through the Rhode Island Sea Grant.

Pelagic shark biology, movements, and abundance studies continued in 2008 with further investigations of pelagic nursery grounds in conjunction with the high seas commercial longline fleet. This collaborative work offers a unique opportunity to sample and tag blue sharks and shortfin makos in a potential nursery area and to collect length-frequency data, biological samples, and conduct conventional and electronic tagging of these species. Life history studies on the basking shark resulted in the publication of a manuscript on ontogenetic vertebral growth patterns for that species and cooperative research on stable isotopes in conjunction with scientists from the Massachusetts Division of Marine Fisheries and the Woods Hole Oceanographic Institute. Other manuscripts published on pelagic species topics included blue shark stock structure based on tagging data, genetic studies, and porbeagle biology and management. The porbeagle work was completed in

conjunction with researchers from Canada and New Zealand. Monitoring the Northeast recreational shark fishing tournaments resulted in the collection of catch data and age, feeding, and reproductive samples from shortfin makos and blue and thresher sharks.

The NEFSC Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) survey continued to investigate known and putative shark nursery areas along the US east coast to describe their species composition, habitat preferences, and determine the relative abundance, distribution and migration of sharks through longline and gillnet sampling and mark-recapture data. In 2008, our COASTSPAN participants were the Georgia Department of Natural Resources, the South Carolina Department of Natural Resources, Coastal Carolina University, and the North Carolina Division of Marine Fisheries. The NEFSC staff conducts the survey in Narragansett and Delaware Bays and limited exploratory sampling in Massachusetts in conjunction with Massachusetts Division of Marine Fisheries. Habitat utilization and essential fish habitat studies of Delaware Bay and Massachusetts sand tigers progressed with the use of satellite telemetry in 2008. NEFSC staff also conducts a survey in the U.S. Virgin Islands (USVI) using COASTSPAN gear and methods. This latter study, published in 2008, is the first comprehensive survey of elasmobranchs in the USVI and has resulted in the identification of critical shark nursery habitat for blacktip and lemon sharks in Fish Bay, USVI.

NEFSC staff recently recovered the shark species catch per set data from the exploratory shark longline surveys conducted by the Sandy Hook and Narragansett Laboratories from 1961 to 1991. This recovery is part of a larger project to electronically recover and archive historical longline surveys and biological observations of large marine predators (swordfish, sharks, tunas, and billfishes) in the North Atlantic. Standardized indices of abundance from this time series were created using a delta-Poisson generalized linear model for the night shark for use in a 2008 publication detailing the status of the U.S. night shark population. Work on the recovery of additional data for this time series, as well as the associated individual shark data, is ongoing to further refine these indices, develop indices of abundance for other shark species, and for future use in shark stock assessments and EFH designations.

f) Marine Mammals

Small Cetaceans:
During August 1-29, 2008, an aerial survey for cetaceans and turtles was conducted using the NOAA Twin Otter. The study area was between New Jersey and Maine, in the waters of the Gulf of Maine and Southern New England. The purpose of the survey was to collect additional data to improve the estimates of g(0) from previously conducted aerial abundance surveys, where g(0) is the probability of detecting a group of animals on the track line. This involved conducting as many circle-backs as feasible using the Hiby circle-back data collection and analyses methods.

Incidental bycatches of cetacean, turtle, and seal species were estimated based on observed takes in commercial fisheries from Maine to North Carolina. Fisheries observed during 2008 included gill nets, otter trawls, mid-water otter trawls, mid-water pair trawls, scallop trawls, shrimp trawls, scallop dredges, clam dredges, purse seines, beach anchored gillnets, bottom longline, pound nets, and some pot and traps. Cetaceans observed taken included harbor porpoises (*Phocoena phocoena*), Risso's dolphins (*Grampus griseus*), common dolphins (*Delphinus delphis*), Atlantic white-sided dolphins (*Lagenorhynchus acutus*), and pilot whales (*Globicephala sp.).* To support Atlantic Take Reduction Teams (e.g., harbor porpoise, coastal bottlenose dolphin, and Atlantic trawl teams), the observer data were investigated to identify environmental factors, fishing practices, or gear characteristics associated with the bycatches.

Large Cetaceans:
A right whale survey was conducted between 16 February and 11 March 2008 aboard the NOAA R/V Delaware II. Cruise objectives included charting right whale (*Eubalaena glacialis*) distribution in the vicinity of Jordan Basin and Cashes Ledge, identifying food resources and oceanographic conditions in these areas, and photographing individual right whales for mark-recapture analyses.

Another right whale cruise was conducted aboard the RV Delaware II between 5 and 31 May 2008. The primary objectives of this cruise were to conduct marine mammal observations from the near-shore waters of Cape Cod to throughout the Great South Channel (GSC) Right Whale Critical Habitat area. Specific

goals included: (1) photographing and biopsy sampling of large cetaceans (North Atlantic right whales, sei and humpback whales) for individual identification; (2) running transect lines to determine cetacean distribution; (3) providing support for the Right Whale Sighting Advisory System (SAS); (4) conducting acoustic doppler current profiles throughout the GSC Right Whale Critical Habitat area; (5) deploying oceanographic drifters to observe ocean currents and drift in and around the Great South Channel; and (6) collecting plankton and copepod samples in close proximity to feeding whales.

The North Atlantic Right Whale Sighting Survey (NARWSS) is a NMFS program dedicated to identifying and documenting the locations of right whales off the northeastern United States. All NARWSS flights conducted in 2008 were systematic surveys and followed track lines within nine survey blocks: Cashes Ledge, Franklin Basin, Georges Basin, Georges Shoal, Great South Channel, Howell Swell, Jeffreys Ledge, Jordan Basin, and Stellwagen Bank. During 2008, 53 flights that involved 295 flight hours were conducted in these survey blocks. In addition, there were directed flights to relocate whale carcasses, entangled whales or support disentanglement efforts. The total number of right whales seen on the aerial surveys (tally of estimated group size, not the number of unique individuals identified from photographs) was 639.

During January - March 2008, skin samples were collected from right whales on the calving grounds in the coastal region (<25 nmi from land) between Savannah, GA and St. Augustine, FL. Whales were located by aerial spotting teams, and skin and blubber samples were obtained using biopsy darts from an inflatable boat. The DNA in the skin can be used to determine sex, and to create a genetic "fingerprint" for later re-identification. These samples will be added to the extensive collection of right whale DNA (obtained from approximately 300 individual right whales) maintained at Trent University in Ontario, Canada. DNA collected and archived through the project will not only help researchers identify individual whales and their paternity, but also to (1) assess genetic variation in the population; (2) determine how many females are reproductively active; (3) monitor the health of individual animals, and (4) better understand the right whale mating system.

In late 2007 we began a three-year project in the Stellwagen Bank National Marine Sanctuary continuing efforts to characterize the underwater acoustic environment of the sanctuary and further examining the effects of noise on resident marine animals. This project is being done in collaboration with NOAA Sanctuaries, Cornell University and Marine Acoustics Inc. (http://stellwagen.noaa.gov/science/passive_acoustics_current.html). Marine autonomous recording units (MARUs) have been deployed in the sanctuary to record low-frequency underwater sound and will be used to gather acoustic data in the sanctuary over a continuous 30 month period. Information regarding the distribution of anthropogenic and natural sources of underwater noise (including vocally-active whales and fish) and information from ongoing whale tagging efforts are being used to better understand whether and how animals change their behaviors in noisy environments.

Another passive acoustics project initiated in 2008 at the NEFSC is aimed at validating passive acoustic techniques. This project is in collaboration with the Massachusetts Division of Marine Fisheries and Cornell University. The objective of the program is to understand the acoustic ecology of the marine animal species in the NE region and how animals use sound over different time and regional scales, seasons, individual, sex and behavioral contexts. Aerial and visual survey data are being used to validate and confirm acoustic events, as well as to model and predict call patterns and usage. This information will then be integrated into available sensor capacities including fixed and mobile acoustic sensors which report either in an archival or real time fashion. The last step will allow us to improve management and monitoring sampling regimes so as to utilize passive acoustics to its best capacity.

Scarification analyses of right and humpback whales continued in 2008. These analyses are used to monitor interactions between whales and fishing gear.

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

Pinnipeds: In 2008, harbor seal (*Phoca vitulina*) and gray seal (*Halichoerus grypus*) scat samples were

collected at several major haul-out sites around outer Cape Cod and eastern Nantucket to determine the diet and diseases of seals in these regions.

Aerial monitoring of major harbor seal and gray seal haul-out sites in southern Massachusetts was contintued in 2008. Likewise, major gray seal pupping colonies in Massachusetts and Maine coastal waters were surveyed. Fourteen aerial seal surveys were conducted, with 10 conducted in Massachusetts and 4 in Maine.

Inter- and intra-specific behavioral interactions of harbor and gray seals were observed at two major haul-out sites on Cape Cod

g) Turtles

The NEFSC collaborated with academics, industry groups, and researchers from other NMFS science centers to assess and reduce sea turtle bycatch in U.S. commercial fisheries in the Northwest Atlantic Ocean. In 2008, research efforts were focused on Mid-Atlantic bottom trawl fisheries, Mid-Atlantic sea scallop fisheries, and Mid-Atlantic gillnet fisheries. In addition to gear research, the NEFSC was involved in estimating bycatch and evaluating mitigation alternatives in trawl and gillnet gear.

NEFSC continued to work with the Atlantic sea scallop fishing industry on the development and testing of a scallop dredge designed to reduce the likelihood of sea turtle injuries during commercial scalloping operations. The modified dredge was experimentally tested using turtle carcasses and was successful at directing all of the observed interactions up and over the dredge, rather than under the dredge where structural damage could be caused by the weight of the dredge.

Additionally, the NEFSC collaborated with industry members and academic and NMFS researchers in developing a modified TED design for the summer flounder fishery. This TED design and two others were tested in the flume tank at Memorial University, St. John's Newfoundland to optimize the configuration of the gear to allow water to pass effectively through the gear even when blockages on the TED and weight in the codend were present. This TED and a subset of the trials of the flume tank testing were further tested in Panama City, Florida for sea turtle exclusion and to compare the results of the flume tank work. Results from this comparison are in the process of being analyzed.

h) Seabirds

The NEFSC continued analysis of seabird bycatch in gillnet fisheries based on observed takes. Bycatch mortality of common loons and red-throated loons in Northeast and Mid-Atlantic gillnets was estimated. Environmental and fishing characteristics in the observer data that are associated with high bycatch rates were also explored.

3. Studies of Fishing Operations

In 2008, NEFSC observers were deployed on 3,058 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 160 marine mammal incidental takes, 14 sea turtle incidental takes, and 161 seabird incidental takes. For most of these animals, take information was recorded including animal condition, length and other relevant body measurements, as well as species identification characteristics. A series of tissue samples were also collected from many of these animals and the entire animal was collected if possible.

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

In the sink anchored gillnet fishery, 755 trips were observed with a total of 3,350 gear retrievals. There were 105 observed marine mammal takes in this fishery (35 harbor porpoises, 31 gray seals, 18 harp seals,

nine harbor seals, five unidentified seals, three Atlantic white-sided dolphins, two common dolphins and two humpback whales). There were also one loggerhead turtle and 85 seabird takes observed in this fishery.

b) Float Drift Gillnet Fishery
There were 20 floating drift gillnet trips with 60 gear retrievals observed in 2008. There were no marine mammal, sea turtle or seabird takes observed.

c) Otter Trawl Fisheries
In the bottom otter trawl fishery 1,103 trips were observed with a total of 17,159 gear retrievals. In addition, there were 20 midwater trawl trips with 113 gear retrievals, 38 scallop trawl trips with 380 gear retrievals and 19 shrimp bottom otter trawl trips with 75 gear retrievals. No twin trawl trips were observed in 2008. In the bottom otter trawl fishery, there were 28 observed marine mammal takes (nine unidentified pilot whales, seven Atlantic white-sided dolphins, four gray seals, two common dolphins, two unidentified dolphins, one harbor porpoise, one minke whale, one unidentified baleen whale and one unidentified toothed whale). There were also eight loggerhead turtles, one unidentified hard-shell turtle and one unidentified turtle take and 23 seabird takes in this fishery. In the mid-water trawl fishery there were six unidentified pilot whale, three Atlantic white-sided dolphin, one Risso's dolphin and 12 seabird takes. In the scallop trawl fishery there were four seabird takes. No marine mammal, sea turtle or seabird takes were observed in the shrimp bottom otter trawl fishery.

d) Sea Scallop Dredge Fishery
In the sea scallop dredge fishery, 660 trips were observed with a total of 40,967 gear retrievals. There were two loggerhead turtle and four seabird takes observed in this fishery.

e) Scottish Seine Fishery
No Scottish seine trips were observed in 2008.

f) Sink Drift Gillnet Fishery
In the sink drift gillnet fishery 172 trips were observed with a total of 1,169 gear retrievals. There were eight observed marine mammal (four harbor porpoises, two, harbor seals, one Atlantic white-sided dolphin and one unidentified seal) and three seabird takes in this fishery.

g) Anchored Floating Gillnet Fishery
No anchored floating gillnet trips were observed in 2008.

h) Mid-water Pair Trawl Fishery
In the mid-water pair trawl fishery 61 trips were observed with a total of 180 gear retrievals. No marine mammal, sea turtle or seabird takes were observed in this fishery.

i) Bottom Longline Fishery
In the bottom long line fishery 79 trips were observed with a total of 550 gear retrievals. There were nine seabird takes observed in this fishery. No marine mammal or sea turtle takes were observed in this fishery.

j) Beach Haul Seine Fishery
In the beach haul gillnet fishery 51 trips were observed with a total of 51 gear retrievals. There were 21 seabird takes observed in this fishery. No marine mammal or sea turtle takes were observed.

k) Pound Net Fishery
No pound net trips were observed in 2008.

l) Handline Fishery
There were two handline trips observed with 3 gear retrievals in 2008. No trolling trips were observed in 2008. No marine mammal, sea turtle or seabird takes were observed in these fisheries.

m) Herring Purse Seine Fishery
There were 35 herring purse seine trips with 77 gear retrievals observed in 2008. There were six gray seal,

one harbor seal, one fin/sei whale and one humpback whale take observed in this fishery. No sea turtle or seabird takes were observed in this fishery.

n) Menhaden Purse Seine Fishery

There were five menhaden purse seine trips with 38 gear retrievals observed in 2008. One loggerhead turtle take was observed in this fishery. No marine mammal or seabird takes were observed.

o) Lobster Pot Fishery

One lobster pot trip with eight gear retrievals was observed in 2008. No marine mammal, sea turtle or seabird takes were observed.

p) Fish Pot Fishery

There were 18 hagfish pot trips with a total of 200 gear retrievals and six black sea bass trips with 60 gear retrievals observed in 2008. No marine mammal, sea turtle or seabird takes were observed in this fishery.

q) Conch Pot Fishery

No conch pot trips were observed in 2008.

r) Red Crab Pot Fishery

There were three red crab pot trips with 42 gear retrievals observed in 2008. No marine mammal, sea turtle or seabird takes were observed in this fishery.

s) Clam Dredge Fishery

In the clam dredge fishery eight trips were observed with a total of 239 gear retrievals. No marine mammal, sea turtle or seabird takes were observed in this fishery.

t) Scallop Beam Trawl Fishery

Two scallop beam trawl trips with 12 gear retrievals were observed in 2008. No marine mammal, sea turtle or seabird takes were observed in this fishery.

4. Population Dynamics Research

a) Atlantic Salmon Research

Atlantic salmon populations in eastern Maine have been formally listed as endangered under the United States Endangered Species Act, and a biological review of the remaining Atlantic salmon populations in the State has recently been finalized that recommends expanding the area to larger watersheds. Spawning populations have dwindled over the years, and both smolt escapement and ocean survival rates have declined. Research programs conducted by the NEFSC, in conjunction with various agency and private partners, are designed to better understand the factors contributing to these declines. Research activities include a variety of field projects in natal rivers, in estuaries, and at sea. These data are used extensively in support of ICES stock assessment activities and NASCO management activities.

Field research in 2008 focused on obtaining smolt production estimates, marine telemetry, and monitoring of fishery removals on the high seas. Smolt production in various rivers is monitored through the use of in-river traps. Trapping programs either generate population estimates via mark-recapture techniques or provide qualitative estimates via index monitoring. A large hatchery smolt tagging program has provided information useful in characterizing smolt emigration and adult returns in relation to stocking practices. Results from these studies indicate differential migration success in relation to stocking location and time and have influenced resource management. Telemetry studies have identified significant mortality during the transition to the marine environment for both wild and hatchery reared smolts. Zones of increased mortality have been identified and potential causal mechanisms (poor physiological condition, predation) and evaluation of different hatchery products is being investigated through follow-up studies. Monitoring the West Greenland fishery and collecting biological data and fishery statistics continued. These data are provided directly to ICES and are required for North American run-reconstruction modeling and for

developing catch advice for this fishery. All of these studies will contribute to recommendations for additional measures to be considered to halt the decline and restore the resource.

b) Cooperative Research

In FY 2008, the NEFSC Cooperative Research Program continued to implement congressionally-directed collaborative research projects, and worked with the regional Fishery Management Councils to determine cooperative research priorities in support of management goals. Additional program goals included strategic planning and programmatic review activities, leveraging resources to promote conservation engineering, and furthering analysis of cooperative research data.

As overall strategic planning initiatives to guide activities for the next five years are finalized, Cooperative Research continues to support the Electronic Logbook/Study Fleet Program, which focuses on using electronic reporting mechanisms for recording haul-based data. This program currently has more than 20 vessels operating in the groundfish, tilefish, squid, scallop, hagfish and SNE yellowtail fisheries.

Conservation engineering efforts in 2008 included providing funds to extension programs to broaden the use of cooperatively-developed bycatch reduction technologies such as the Ruhle Trawl and the Topless Shrimp Trawl.

2008 Research Set-Aside competitions were held for Scallops, Monkfish, and Mid-Atlantic Multispecies, resulting in 14 projects worth over $8 million. The Cooperative Research Program also began implementation of a programmatic review of all Research Set-Aside Programs to assess performance and utility. This review process will be completed in 2009, and recommendations implemented to improve the Research Set-Aside programs.

Through a grant to the Northeast Consortium, Cooperative Research continued to provide funding for the Environmental Monitors on Lobster Traps, or eMOLT program. This partnership, involving NOAA, the State of Maine, the Commonwealth of Massachusetts, the Downeast and Atlantic Offshore Lobstermen's Associations, the Gulf of Maine Lobster Foundation, and the Marine Science Department at Southern Maine Community College (SMCC) in Portland, Maine, facilitates environmental monitoring using temperature probes on lobster pots and trawls. The project continues to collect hourly bottom temperatures from nearly 100 fixed locations around the Gulf of Maine and the Southern New England Shelf. Since the inception of the program in 2001 lobstermen have been securing internally-recording temperature probes to their traps. Data are typically downloaded once per year but efforts are underway to telemeter data with each haul. While monitoring inter-annual changes in bottom temperature is the primary focus of the project, other phases of the project have collected time series of salinity and current flow. A low-cost satellite-tracked drifter was developed and used on various other projects to monitor surface flow. In the most recent phase of the project, a low-cost moored bottom-current meter has been developed. For more information and data access, visit: http://emolt.org.

During 2008, a collaborative monkfish survey design and implementation plan was developed in conjunction with the Monkfish Defense fund, Garden State Seafood Association, Rutgers University, and commercial fishing partners. Objectives of the survey include characterization of the size, age and sex composition and geographic distribution of the monkfish population, and special studies including tagging, reproductive biology, genetics, otolith microconstituents, isotope analysis of diet and distribution with respect to temperature. Results of the industry-based monkfish survey will also be compared with results from the new NEFSC survey vessel FSV Bigelow.

Tagging programs remain a significant activity of the Northeast Cooperative Research Program, and recent efforts have been focused on ensuring that tagging studies provide improved data for management purposes.

Atlantic Cod - With support from Cooperative Research, data from the five-year collaborative Northeast Regional Cod Tagging Program led by the Gulf of Maine Research Institute were incorporated into the 3rd Groundfish Assessment Review Meeting (GARM). Between March 2003 and July 2005, over 140,000 cod were tagged from 106 commercial vessels in the Gulf of Maine, Georges Bank, and Scotian Shelf

management areas, with more than 6,500 recaptures recorded by the start of 2008. Data resulting from these recaptures were especially beneficial in terms of providing growth and movement information to the 2008 benchmark stock assessment for Atlantic cod.

Yellowtail Flounder

The NEFSC cooperative research program continues to support the improvement of data quality for the yellowtail flounder tagging program through its tag reward program and the implementation of the state-of-the-art database system. In 2008, the existing yellowtail flounder tagging database was fully migrated into a relational database with online features and became fully operational. The new database system provides improved capability to summarize release and recapture events for analyses and also generates reward letters and GIS maps for outreach purposes.

Between 2003 and 2006, a total of 45,661 tags were released from seven commercial vessels in the Gulf of Maine, Georges Bank and Southern New England-Mid Atlantic regions with over 3700 recaptures by the end of 2008. The relative return rate of lottery to high-reward tags implies a 57% reporting rate, which is exceptional for a commercial fishery. Recaptures from the tagging study indicate frequent movements within Cape Cod and Georges Bank stock areas with a less frequent movement between stock areas. While many tagged yellowtail flounder are still at large and recaptures continue to be reported and supported by the database system, various analytical framework (i.e. simulation studies, Finite State Continuous Time model and MARK analyses) are being explored to determine alternative approaches for incorporating the tagging study results into future yellowtail flounder stock assessment analyses.

c) Stock Assessment Methods Development

Many national and international studies have concluded that stock assessments should evaluate resource status using a number of different analytical approaches. This provides some indication of the robustness of conclusions regarding stock status. To this end, NEFSC researchers have been collaborating with other NOAA fisheries scientists to develop a standardized suite of methods collected into a software Atoolbox@. The NOAA Fisheries Toolbox (NFT) incorporates a wide range of methods, such as virtual population analysis, reference point estimation, surplus production and forward-projection methods, into a stable environment with tested software products. The NFT is used for many routine assessment tasks. Work on the package continues to incorporate more modules, to test software for reliability, and to make the NFT more user-friendly. No major developments occurred in 2008. The complete package may be accessed at http:/nft.nefsc.noaa.gov (note that a password is no longer required).

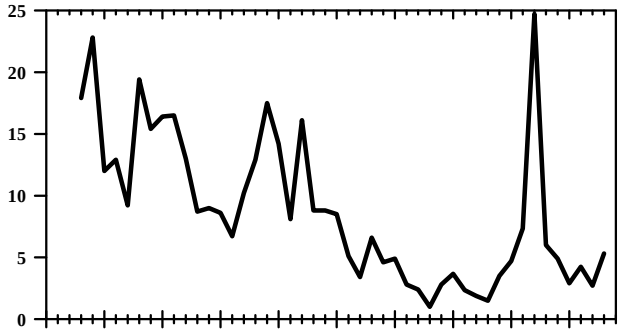

Figure 1. NEFSC autumn bottom trawl survey biomass indices for Gulf of Maine cod.

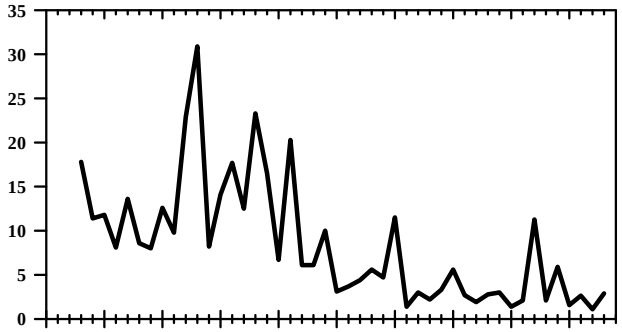

Figure 2. NEFSC autumn bottom trawl survey biomass indices for Georges Bank cod.

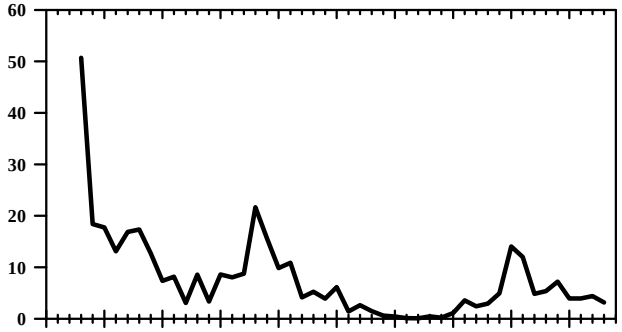

Figure 3. NEFSC autumn bottom trawl survey biomass indices for Gulf of Maine haddock.

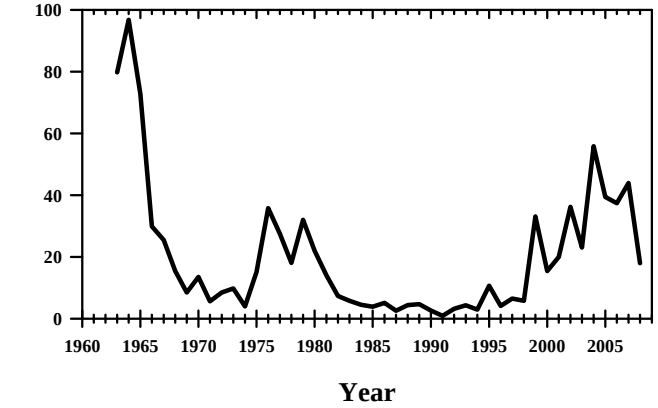

Figure 4. NEFSC autumn bottom trawl survey biomass indices for Georges Bank haddock.

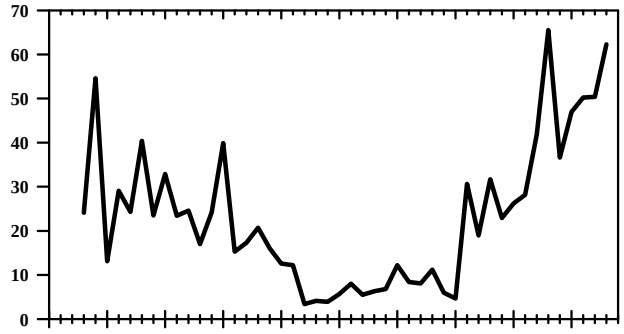

Figure 5. NEFSC autumn bottom trawl survey biomass indices for redfish.

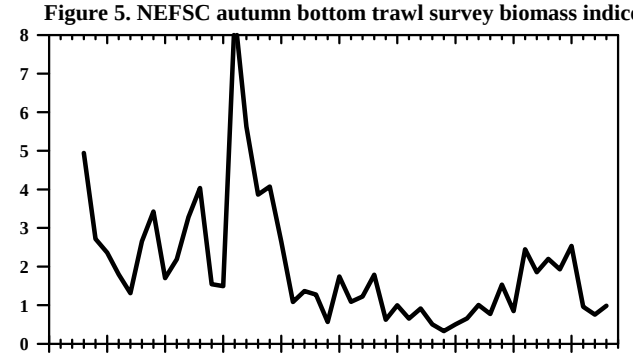

Figure 6. NEFSC autumn bottom trawl survey biomass indices for pollock.

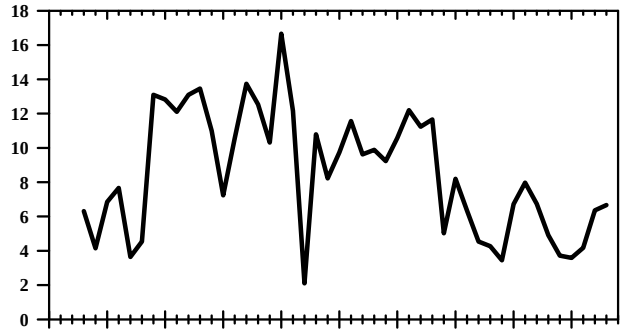

Figure 7. NEFSC autumn bottom trawl survey biomass indices for white hake.

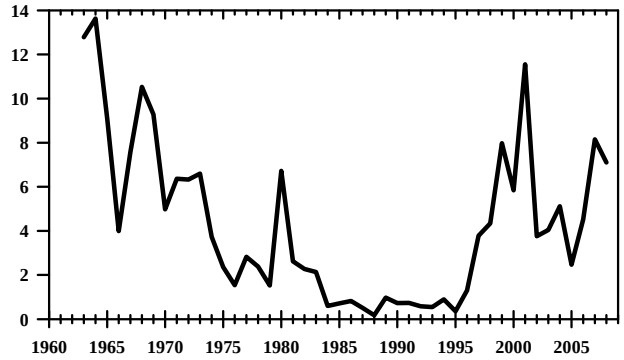

Figure 8. NEFSC autumn bottom trawl survey biomass indices for Georges Bank yellowtail flounder.

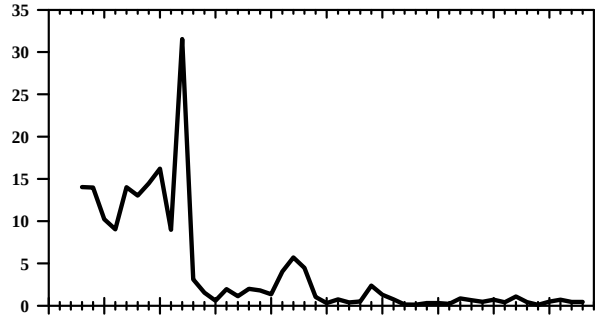

Figure 9. NEFSC autumn bottom trawl survey biomass indices for Southern New England-Mid-Atlantic yellowtail flounder.

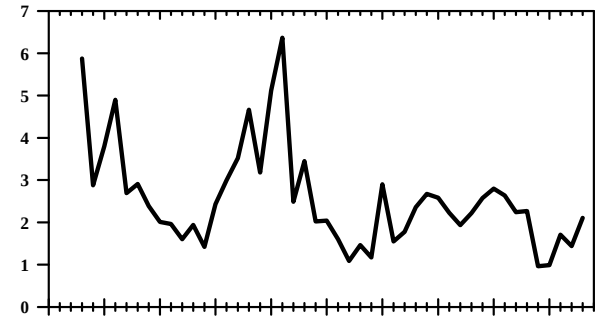

Figure 10. NEFSC autumn bottom trawl survey biomass indices for American plaice.

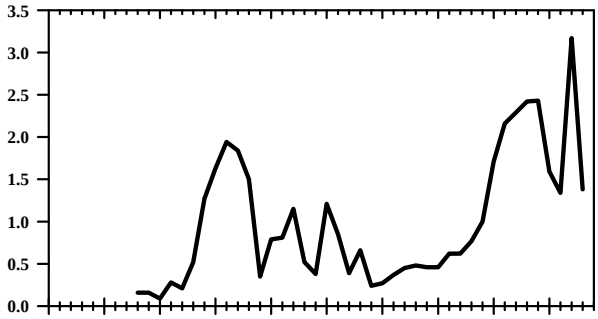

Figure 11. NEFSC spring bottom trawl survey biomass indices for summer flounder.

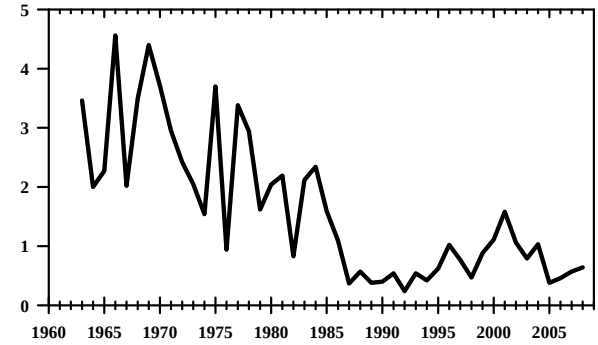

Figure 12. NEFSC autumn bottom trawl survey biomass indices for witch flounder.

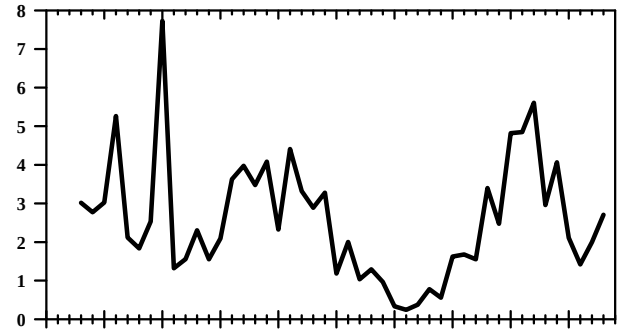

Figure 13. NEFSC autumn bottom trawl survey biomass indices for Georges Bank winter flounder.

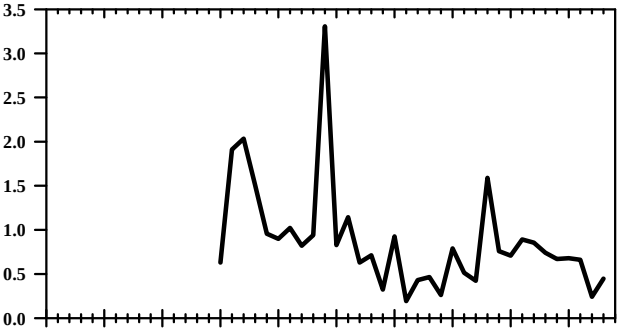

Figure 14. NEFSC autumn bottom trawl survey biomass indices for northern windowpane flounder.

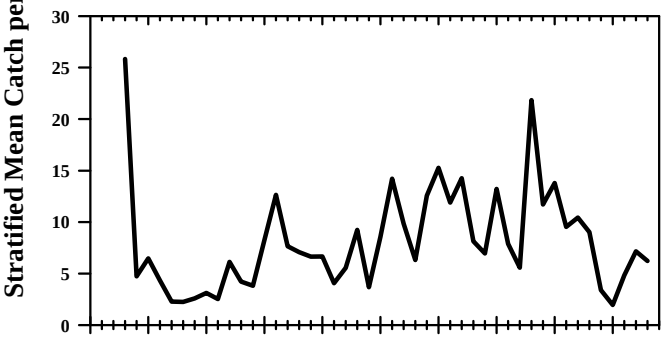

Figure 15. NEFSC autumn bottom trawl survey biomass indices for northern silver hake.

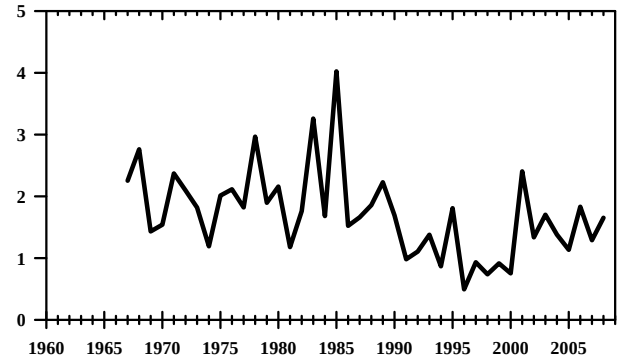

Figure 16. NEFSC autumn bottom trawl survey biomass indices for southern silver hake.

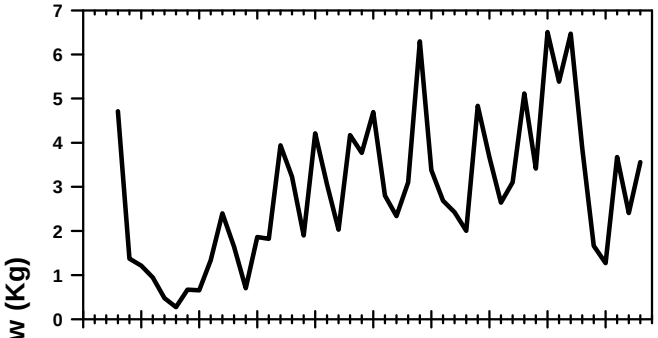

Figure 17. NEFSC autumn bottom trawl survey biomass indices for northern red hake.

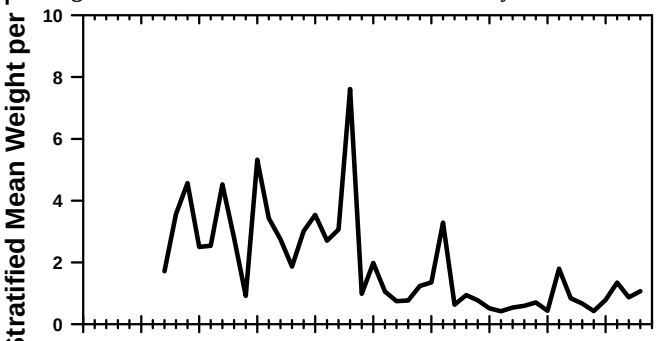

Figure 18. NEFSC autumn bottom trawl survey biomass indices for southern red hake.

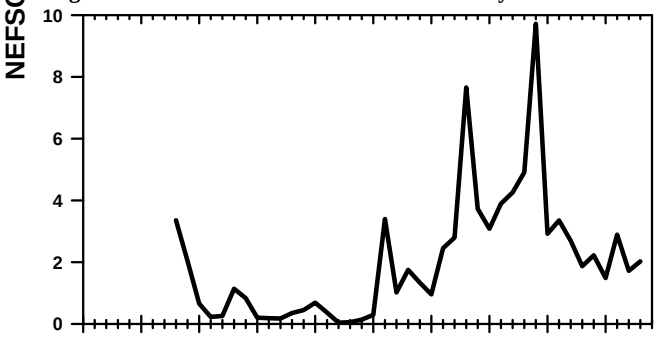

Figure 19. NEFSC spring bottom trawl survey biomass indices for Atlantic herring.

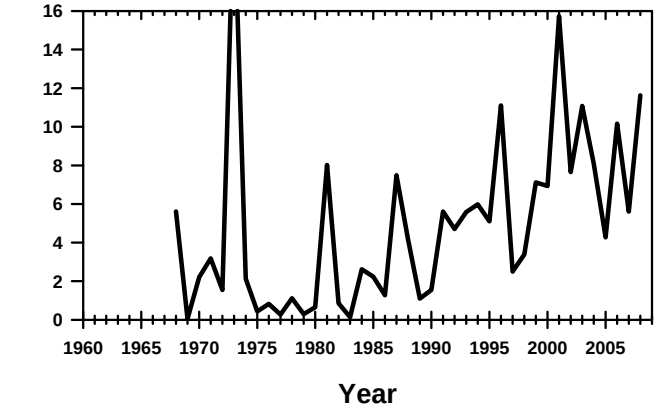

Figure 20. NEFSC spring bottom trawl survey biomass indices for Atlantic mackerel.

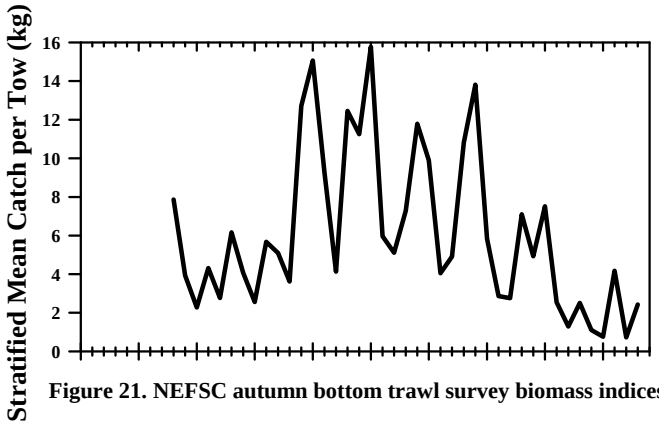

Figure 21. NEFSC autumn bottom trawl survey biomass indices for butterfish.

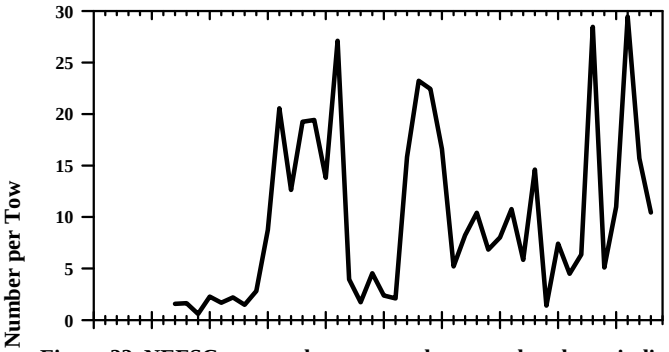

Figure 22. NEFSC autumn bottom trawl survey abundance indices for *Illex*.

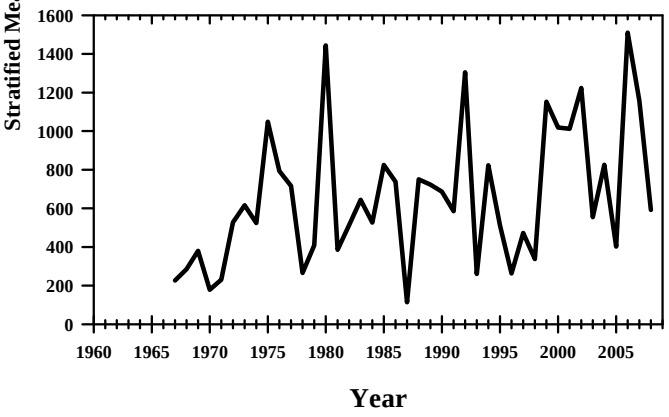

Figure 23. NEFSC autumn bottom trawl survey abundance indices for *Loligo*.

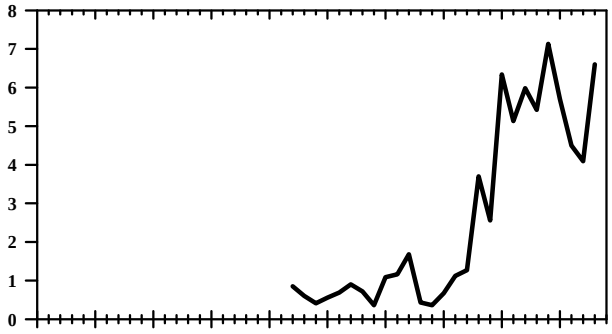

Figure 24. NEFSC scallop survey biomass indices for Georges Bank sea scallops.

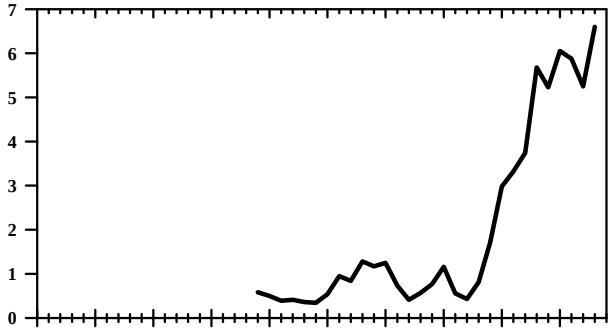

Figure 25. NEFSC scallop survey biomass indices for Mid-Atlantic Bight sea scallops.

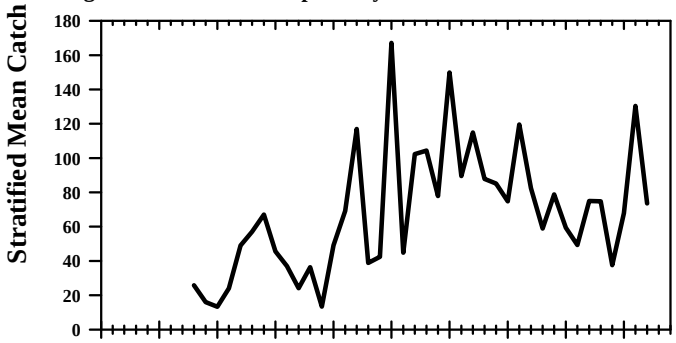

Figure 26. NEFSC spring survey biomass indices for spiny dogfish.

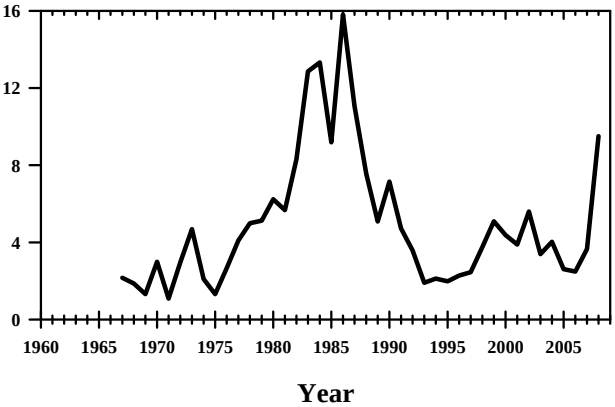

Figure 27. NEFSC autumn survey biomass indices for winter skate.

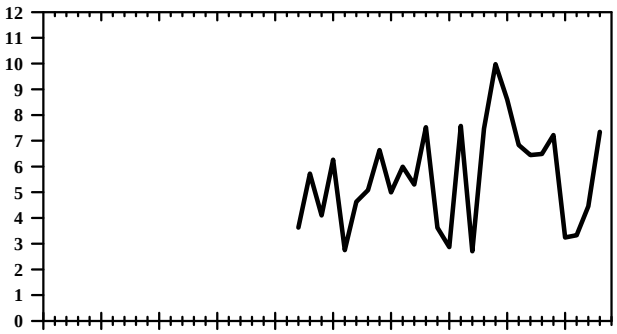

Figure 28. NEFSC spring survey biomass indices for little skate.

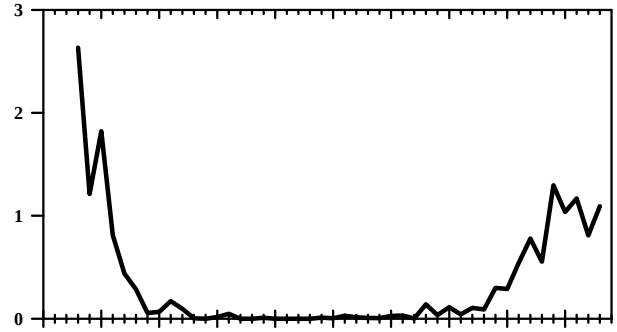

Figure 29. NEFSC autumn survey biomass indices for barndoor skate.

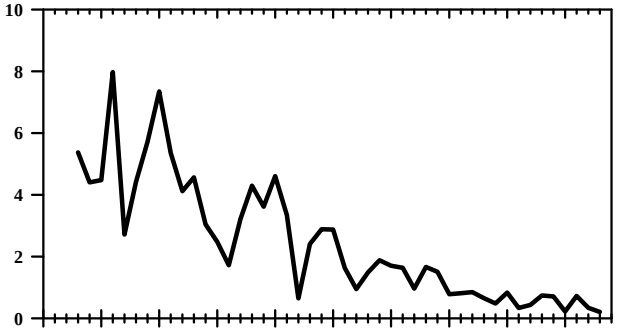

Figure 30. NEFSC autumn survey biomass indices for thorny skate.

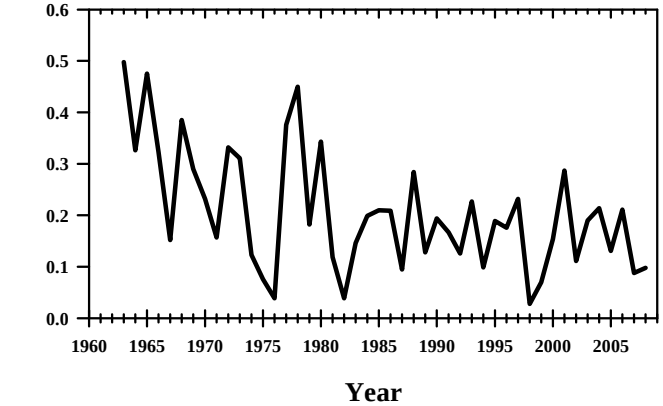

Figure 31. NEFSC autumn survey biomass indices for smooth skate.

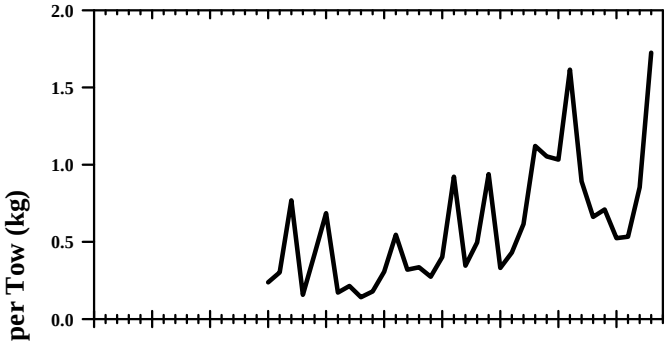

Figure 32. NEFSC autumn survey biomass indices for clearnose skate.

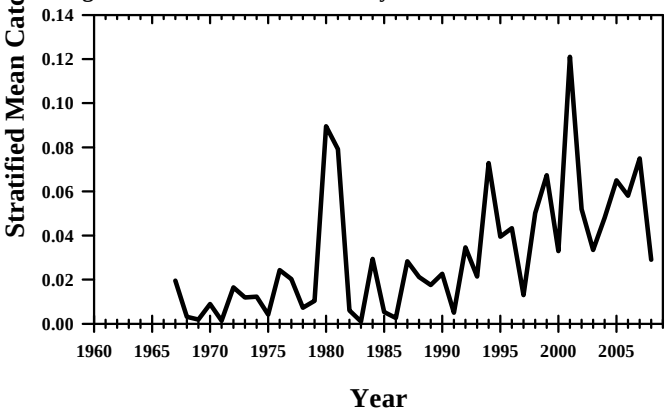

Figure 33. NEFSC autumn survey biomass indices for rosette skate.