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United States Research Report for 2007

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 2007 were 7,668 mt, a 34% increase from 2006 landings of 5,724 mt and a 22% increase from the 6,282 mt landed in 2005.

USA cod landings from the Gulf of Maine (Div. 5Y) in 2007 were 3,990 mt, a 32% increase from 3,030 mt landed in 2006. 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 2003, the autumn survey biomass index has remained among the lowest in the survey series (Figure 1).

USA cod landings from Georges Bank (Div. 5Z and SA 6) in 2007 were 3,678 mt, a 37% increase from 2,694 mt landed in 2006. The NEFSC research vessel survey biomass indices have remained near record-low levels during 1991-2007, 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 decreased in 2007 to a record-low (Figure 2).

2. Haddock

United States haddock (*Melanogrammus aeglefinus*) commercial landings increased 11% from 3,261 mt in 2006 to 3,626 mt in 2007. Georges Bank (Div. 5Z) haddock landings increased 11% from 2,643 mt in 2006 to 2,930 mt in 2007. Gulf of Maine (Div. 5Y) haddock landings increased by 13% between 2006 and 2007 from 618 mt to 696 mt. Landings from both stocks are below historical levels.

Research vessel survey biomass indices increased in 2007 for both the Georges Bank and Gulf of Maine stocks (Figures 3 and 4). Stock biomass of Georges Bank haddock has increased sharply in recent years due to the exceptional 2003 year class. Gulf of Maine stock biomass has decreased from a recent high in 2000 as the strong 1998 year class has experienced both natural and fishing mortality.

3. Redfish

USA landings of Acadian redfish (*Sebastes fasciatus*) increased by 58% from 499 mt in 2006 to 787 mt in 2007. 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 6,067 mt in 2006 to 8,371 mt in 2007. 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 and 2007, 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 10% from 1,700 mt in 2006 to 1,532 mt in 2007. 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, but increased slightly in 2006 and 2007 (Figure 7).

6. Yellowtail Flounder

USA landings of yellowtail flounder (*Limanda ferruginea*) decreased 10% from 1,939 mt in 2006 to 1,753 mt in 2007. Research vessel survey indices suggest that the Georges Bank stock (Div. 5Z, E of 69E) is at a moderate biomass level, while the Southern New England-Mid Atlantic stock (Div. 5Z W of 69E 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 2007 totaled 9,416 mt, 22% lower than in 2006. Summer flounder (*Paralichthys dentatus*) (48%), winter flounder (*Pseudopleuronectes americanus*) (28%), witch flounder (*Glyptocephalus cynoglossus*) (11%), American plaice (*Hippoglossoides platessoides*) (11%), and windowpane flounder (*Scophthalmus aquosus*) (2%) accounted for virtually all of the 'other flounder' landings in 2007. Compared to 2006, commercial landings in 2007 were higher for windowpane flounder (95%) but lower for winter flounder (-3%), American plaice (-10%), summer flounder (-29%) and witch flounder (-42%). Research vessel survey indices in 2007 increased for summer flounder, witch flounder and winter flounder and decreased for American plaice and windowpane flounder (Figures 10-14).

8. Silver hake

USA landings of silver hake (*Merluccius bilinearis*) increased by 8% from 5,564 mt in 2006 to 6,007 mt in 2007. 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 declined (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 and remained at levels last observed in the 1980s (Figure 16).

9. Red Hake

USA landings of red hake (*Urophycis chuss*) decreased 2% from 456 mt in 2006 to 448 mt in 2007. 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 been slightly higher (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*) declined 22% from 102,186 mt in 2006 to 80,213 mt in 2007. Commercial landings from Georges Bank decreased 39 % from 16,229 mt in 2006 to 9,845 mt in 2007. 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). 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 57% from 56,627 mt in 2006 to 24,295 mt in 2007. Recreational catch declined 46% from 1,631 mt in 2006 to 882 mt in 2007. Spring survey indices increased steadily during the 1990s and have averaged 8.7 kg/tow during 2000-2007 (Figure 20). 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*) increased 21% from 545 mt in 2006 to 662 mt in 2007. 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 in 2007 to a time series low (Figure 21).

13. Squids

USA landings of northern shortfin squid (*Illex illecebrosus*) during 2007 totaled 9,022 mt, 35% lower than in 2006 (13,944 mt). The NEFSC autumn survey relative abundance index in 2007 declined from the record high value in 2006 (Figure 22)

USA landings of longfin inshore squid (*Loligo pealeii*) in 2007 totaled 12,268 mt, 23% lower than in 2006 (15,907 mt). The NEFSC autumn survey abundance index in 2007 was only slightly lower than the record-high 2006 index (Figure 23).

14. Sea Scallops

USA sea scallop (*Placopecten magellanicus*) landings in 2007 were 26,403 mt (meats), about the same as 2006, and over twice the long-term (1957-2007) average. Nearly 36% (9,382 mt) of the 2007 landings was harvested from Georges Bank, while 62% (16,460 mt) was from the Mid-Atlantic. Since 2000, most of the annual landings have come from the Mid-Atlantic region, except in 2006. By contrast, during 1957-1999, most USA sea scallop landings were harvested from Georges Bank.

Research vessel survey indices in 2007 showed modest declines in sea scallop biomass on both Georges Bank and the Mid-Atlantic, but biomass in both regions remained high by historical standards (Figures 24 and 25). Most of the scallop biomass on Georges Bank is in 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. Nearly 7,500 mt of scallop meats were harvested from the Elephant Trunk area in 2007 and the 2008 scallop harvest from this area is expected to exceed 10,000 mt. Recruitment in 2007 was about average on Georges Bank and in the Mid-Atlantic area.

15. Small Elasmobranchs

USA landings of spiny dogfish (*Squalus acanthias*) increased by 25% from 2,249 mt in 2006 to 2,807 mt in 2007. Survey indices, which are highly variable, generally declined from the early 1990s through 2005 but increased sharply in 2006 and remained high in 2007 (Figure 26).

USA landings of skates (most still landed as unclassified) increased by 17% between 2006 and 2007 from 16,135 mt to 18,826 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 in the last few years. 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 have declined in the past five years (Figures 32 and 33).

B. Special Research Studies

1. Environmental Studies

a) Hydrographic Studies

A total of 1,809 CTD (conductivity, temperature, depth) profiles were collected on Northeast Fisheries Science Center (NEFSC) cruises during 2007. Of these, 1,745 were obtained in NAFO Subareas 4 and 5. The CTD data were processed and archived in an ORACLE database accessible at: http://www.nefsc.noaa.gov/epd/ocean/MainPage/index.html. Reports of oceanographic conditions using these data are available at ftp://ftp.nefsc.noaa.gov/pub/hydro/cruise_rpts/2007/. Similar reports have been issued annually since 1991.

The Environmental Monitors on Lobster Traps (eMOLT) project continues to collect hourly bottom temperatures from nearly 100 fixed locations in the Gulf of Maine and on the Southern New England Shelf. Lobstermen have been securing internally-recoding temperature probes to their traps since 2001. Data are typically downloaded once per year, but efforts are underway to telemeter data for each haul. Monitoring inter-annual changes in bottom temperature is the primary focus of the project, although salinity and current flow data have also been collected. For more information and data access, visit “http://emolt.org”.

b) Plankton Studies

During 2007, zooplankton community distribution and abundance were monitored using 706 bongo net tows taken on ten 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 six transects across the Gulf of Maine from Cape Sable, NS to Boston, and eleven transects across the Mid-Atlantic Bight from New York to the Gulf Stream.

c) Benthic Studies

The NEFSC's James J. Howard and Woods Hole laboratories, working with the U. S. Geological Survey and University of Rhode Island, continued studies (begun in 1999, with some aspects earlier) to characterize habitats and fish-habitat relationships and to determine habitat effects of mobile fishing gears in New England and Mid-Atlantic waters. A July 2007 cruise was conducted on Georges Bank with four objectives: (1) determine distribution of invasive colonial tunicate *Didemnum vexillum* on northern Georges Bank gravel habitat both inside and outside the Closed Area II Habitat Area of Particular Concern (HAPC); (2) document relationships to other ecosystem components and substrates; (3) collect tunicate specimens for further study [including DNA analysis] and collect near-bottom water samples in tunicate areas; and (4) continue monitoring recovery and productivity of untrawled gravel habitats in the HAPC on northeastern Georges Bank. Samples were obtained by dredging, trawling, and the use of the USGS SEABOSS video/camera vehicle.

In an area outside of the Closed Area II HAPC (where dense tunicate colonies have been found since 2003) intense bottom fishing appears to have fragmented, but not killed the tunicate colonies. Percent cover was reduced compared with 2006, probably in response to bottom fishing. Bottom substrates inside Closed Area II had a higher percent cover of *D. vexillum*, and numerous tunicate colonies occurred in the dredge and otter trawl samples. The positive association between *D. vexillum* and the polychaetes, *Nereis* and *Harmothoe* noted in previous years continued to be recorded in this area. These worms, commonly found burrowing between the tunicate colonies and the pebble and shell substrate, are hypothesized to be protected from fish predation by the presence of the tunicate. Trawl catches in these two areas were dominated by haddock and longhorn sculpin, respectively. Tunicate fragments were observed in stomachs of haddock and winter flounder. Samples of *D. vexillum* were preserved (formalin, alcohol, freezing) for taxonomic, genomic, and chemical analyses. The invasive tunicate was not seen at any of the dredge stations on the Canadian side of Georges Bank, although small colonies of the native *Didemnum albidum* were found in the dredge samples. These samples were also preserved in ethanol for subsequent DNA analysis and in formalin for morphological identification. A new undisturbed area was found in the HAPC, just inside of the US border. This area lacked *D. exillum*, but had a high cover of emergent epifauna (hydroids, bryozoans, and sponges), and exhibited an unusually high concentration of haddock. Aside from a voucher sample of sessile invertebrates, no biological sampling was performed in this area.

A March 2007 cruise to the Hudson Canyon area (off New Jersey) was undertaken to: (1) identify overwintering habitats of juvenile seasonal migrant fish species (black sea bass, scup, sea robins); (2) collect acoustic bottom data to create maps of two habitat areas of interest; and (3) evaluate the occurrence of tropical /subtropical species as indicators of climate change. Sampling with a 2 m beam trawl yielded few juvenile seasonal migrants from canyon rim habitats, where these migrants were found in a previous winter; only northern sea robins were caught. It is suspected that the unusual winter weather in 2007 caused other seasonal migrant species to alter their overwintering habitat locations. Species composition of winter beam trawl samples were similar to those obtained in summer and fall, but small spider crabs (*Euprognatha rastellifera*) and rose shrimp (*Parapenaeus politus*) were far more abundant than in previous cruises. The latter is a large-bodied shrimp not now actively fished, but of potential commercial interest. It is not clear whether this is a normal seasonal pattern or a result of the unusually warm winter. The presence of beds of deepwater cup corals (*Dasmosmilia lymani*) and sponges (primarily *Myxilla incrustans*) along the rim of Hudson Canyon detected on previous cruises was confirmed. Beam trawling yielded three tropical/subtropical decapod shrimp species not previously reported north of Cape Hatteras (*Mesopenaeus tropicalis, Solenocera atlantidis, Processa profunda*), including one species (*P. profunda*) with gravid females, indicating local reproductive activity. Several other southern species, mostly decapod shrimps and crabs, have been found in the vicinity of Hudson Canyon since the start of the Hudson Canyon program in 2001. While none of these species was numerically important in catches, such incidences may prove a good indicator of climatic change. Two habitat areas of interest were successfully mapped utilizing single beam sonar, clarifying uncertainties raised by previous mapping efforts. One area was a steep-sided ravine that cut down the side of the canyon wall and probably harbored deepwater coral habitat. The other area was characterized by long, shallow linear trenches (probably relict iceberg scour marks) that contained substantial quantities of monkfish.

Inshore studies continued on habitat requirements of resource species and on fishing gear impacts on habitat. In an area supporting a winter dredge fishery for blue crabs, *Callinectes sapidus*, effects of a commercial crab rake on beds of amphipod tubes and other habitat features are being documented. The dredging removes the tubes, but the amphipod populations become rapidly reestablished. Other ongoing projects involve: (1) examining the relationships between springtime weather patterns and bivalve recruitment over the past two decades; and (2) synthesizing information on the biology, ecology and fisheries for the bay scallop, *Argopecten irradians*. The Milford Laboratory has initiated a cooperative research project with the East Coast Shellfish Research Institute and commercial shellfish growers to investigate interactions between shellfish cultivation methods and habitat. Mechanical harvesting of oysters and clams using dredges clearly affects the benthic community. What is not clearly known is the extent of the impacts and if there are subsequent positive ecological services provided by shellfish cultivation. In a multiyear effort, the Milford Laboratory will review existing literature, collect observations from the shellfish industry and the environmental community, and conduct field experiments to address this issue. Effects of mechanical bottom dragging of oyster gear, clam harvesting using hydraulic jets, and hand raking will be evaluated. All sampling will be minimally invasive and have little or no effect on ongoing culture activities. Results of this study should shed new light on how aquacultural practices affect habitat ecology and help to find ways for minimizing potential effects.

2. Biological Studies

a) Fish Species

Flatfishes: The roles of the environment and of parentage to offspring quality and viability are important for a thorough understanding of recruitment patterns as well as the aquacultural potential of a species. We are analyzing data from an experiment conducted in during 2005-06 on winter flounder, *Pseudopleuronectes americanus*. The experiment 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.

Spatial time series analyses were conducted to examine synchrony in the fluctuations of age-0 winter flounder (*Pseudopleuronectes americanus*) production in 19 Southern New England (SNE) coastal nurseries over the past 30 years. During 1990 to 2004, nursery production was synchronized at scales up to ~200 km, based upon spatial trends in cross-correlations of first differenced age-0 abundance time series. However, sliding window analysis of 1975-2005 time series data collected in six nurseries ≤55 km apart in northern SNE indicated that synchrony increased from low to high values in the early 1990s. Synchrony in production also increased among three nurseries ≤ 65 km apart in southern SNE from 1984 to 2004. These results indicate that interannual fluctuations in nursery production became synchronized at coarser spatial scales throughout SNE during the 1990's. This coarsening of the spatial scale of control of winter flounder nursery production was coincident with an increase in the frequency of springs with warm temperatures believed to negatively affect early life history processes. Spatial synchronization of winter flounder nursery ground production may have destabilized age class structure and population dynamics in the region.

Gadids: Field and laboratory research continues on Atlantic tomcod, *Microgadus tomcod*, a locally abundant inshore gadid of the Northeastern USA and Eastern Canada. Tomcod have 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 2007-08 also includes an assessment of the combined effects of PAHs and PCBs on ecologically relevant toxic endpoints. Collaborations in 2007-08 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 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 continue in evaluating patterns of ichthyofauna abundance in the Hudson River Estuary Ecosystem and processes that affect abundance. 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.

b) Resource Survey Cruises

During 2007, personnel from the Ecosystems Surveys Branch (ESB) staged, staffed and supported the winter, spring and fall multispecies bottom trawl, northern shrimp trawl, gear experiment trawl, and gear calibration trawl surveys. Additional staff and gear support was provided for the sea scallop dredge, hydroacoustic, acoustic trials, non-ESB and cooperative surveys for a total of 269 research and charter vessel sea days. NOAA scientific staff participated on a total of 2,360 staff sea days and volunteers contributed another 744 person sea days. ESB cruises occupied 1,770 stations in an area extending from Cape Hatteras, North Carolina to Nova Scotia including the Gulf of Maine. A total of 2,580,721 length measurements were taken from 370 species during these cruises. Ecosystem survey data currently are utilized as fishery independent abundance or biomass inputs in 48 single species stock assessments and in several ecosystem dynamics modeling efforts.

Significant sampling effort was also expended in fulfilling requests from 61 NOAA and University investigators for samples or observations during various survey cruises. These efforts included 16,382 feeding ecology observations, collecting 25,871 ageing structures, and obtaining 32,812 samples or individual specimens to support ancillary shore based research.

Scientists, regional gear manufacturers, and commercial fishery stakeholders collaborated to test and utilize a new survey bottom trawling system used aboard the new fishery survey vessel, the *FSV Henry B. Bigelow*. A similar collaborative effort is currently underway to redesign the sampling dredge to be used in NEFSC sea scallop surveys, and to test this new gear in 2008. The *FSV Henry B. Bigelow* began scientific data collection operations out of Newport, Rhode Island in September 2007. Initial survey efforts have focused on the calibration of bottom trawl catchability, using standard bottom trawl survey procedures, with the *RV Albatross IV*.

c) Age and Growth

Approximately 45,000 age determinations for 11 species of finfish were completed in 2007 by Woods Hole Laboratory staff in support of resource assessment analyses. In addition to Atlantic cod (7,072), haddock

(8,452), and yellowtail flounder (10,129), 5,462 summer flounder were aged. Age determinations for Atlantic herring, pollock, goosefish, Acadian redfish, witch flounder, winter flounder, and white hake totaled 13,626.

Cod and haddock age structures were exchanged with age readers from Fisheries & Oceans Canada (St. Andrews Biological Station) in a continuing effort to maintain comparability of age determinations between laboratories. 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 underway in 2007 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; and (3) a study examining growth chronologies in Acadian redfish. A project completed in 2007 examined recent trends in mean weights-at-age and sex ratios for several flatfish species. A research project initiated in 2007 was age validation of Atlantic surfclams using sectioned chondrophores obtained from samples collected across the geographic range of the species. This study should be completed in early 2009.

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 gadids.

Food habits samples were collected on the northeastern and Mid-Atlantic continental shelf during NEFSC winter, spring, and autumn surveys. Estimates of prey volume and composition were made at sea for selected species. During the 2007 winter survey, 3,684 stomachs from 48 species were examined, while 6,303 stomachs from 54 species, and 6,136 stomachs from 59 species were examined during the spring and autumn 2007 surveys, respectively. Diet sampling emphasized small pelagics, elasmobranchs, gadids, flatfishes, and lesser known species.

The 35 year time series (1973-2007) 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 500,000 stomach samples. The processing of the 2007 bottom trawl survey food habits data is scheduled for completion in 2008.

Staff published several papers and reports on a wide range of trophic ecology issues in the Northwest Atlantic ecosystem. Other published papers addressed the theoretical and practical implications and implementation of ecosystem-based fisheries management. 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 2007. Information was received on about 5,800 tagged and 375 recaptured fish bringing the total numbers tagged to 205,800 sharks of more than 50 species and 12,425 sharks recaptured of 33 species. Identification placards for pelagic and coastal shark species were produced and distributed in collaboration with RI Sea Grant.

The bi-annual fishery independent survey of Atlantic large and small coastal sharks in US waters was conducted in spring 2007. The goals of the survey were to: (1) monitor the species composition and sizes,

distribution, and abundance of sharks in the coastal Atlantic; (2) tag and inject sharks for age validation and migration studies; (3) collect biological samples for age and growth, feeding ecology, and reproductive studies; and (4) collect morphometric data for size conversions. The time series of abundance indices from this survey are critical to the evaluation of coastal Atlantic shark species. The 2007 survey collected 457 fish (447 sharks), representing sixteen species. Sharks accounted for 98% of the total catch; sandbar sharks were the most common, followed by tiger and dusky sharks. As part of the survey, bottom longlines were set in the closed area off North Carolina. Cooperative work included deployment of electronic tags and sampling of blood, heart and other tissues for ribosomal DNA species identification marker studies and for assessing post-release survivorship.

Studies of pelagic shark biology, movements, and abundance continued in 2007. Pelagic sets were made subsequent to the coastal survey as a continuation of longline surveys for highly migratory swordfish, tunas, and sharks conducted by NMFS periodically since the 1950s. In addition, an investigation into pelagic nursery grounds was initiated with the collection of length-frequency data, biological samples, and conventional and electronic tagging of pelagic shark species as part of cooperative work with the high seas commercial longline fleet. The collaborative program to examine the biology and population dynamics of the blue shark and shortfin mako in the North Atlantic continued (in conjunction with scientists at the University of Washington and University of Rhode Island). In 2007, survival rates estimates from mark-recapture data were published for shortfin mako shark and demographic and risk analyses published for blue shark. The second year of work continued on research funded by the Large Pelagics Research Center's external grants program on habitat utilization, movement patterns, and post-release survivorship of porbeagle sharks captured on longline in the North Atlantic. This cooperative work with Massachusetts Division of Marine Fisheries (MDMF) and the University of Massachusetts resulted in the deployment 20 PSATs on porbeagles. Additional collaborative research with scientists at the Woods Hole Oceanographic Institution and the MDMF, involves the use of isotope levels in basking shark vertebrae to assess migratory behavior and ocean connectivity in this species. Other pelagic work included the continuation of a life history study of the torpedo ray with data collection and sampling for age and growth, reproduction, and food habits (part of a University of Rhode Island graduate student's master's thesis), collection of catch data and age, feeding, and reproductive samples at Northeast recreational fishing tournaments, and a manuscript completed on seal predation by sharks on Sable Island, NS, Canada (in conjunction with Zoe Lucas).

Staff participated in the Southeast Data, Assessment, and Review (SEDAR) Workshop for the assessment of the U.S. small coastal shark complex. Seven working papers were prepared summarizing small coastal species mark/recapture data, NEFSC historical longline surveys, relative abundance trends for small coastal sharks from the COASTSPAN surveys in South Carolina and Georgia, catch rate information obtained from the NMFS northeast longline surveys, relative abundance trends for Atlantic sharpnose sharks observed in the NEFSC Observer Program, and relative abundance trends for small coastal sharks caught during the University of North Carolina shark longline survey.

Habitat utilization and essential fish habitat studies of Delaware Bay sandbar sharks and sand tigers continued. These studies include investigations into sandbar shark reproductive dynamics and nursery grounds using a longline survey with a random stratified sampling plan based on depth and geographic location. The time series developed from this survey is used to estimate and monitor the relative abundance and population size of sandbar sharks in the Bay throughout the nursery season and from year to year. A study initiated in 2006, using a larger version of the longline survey gear, continued to target sand tigers and larger sandbar sharks for identifying EFH and for future stock assessment purposes. This study incorporates historical NEFSC sampling stations for comparison to pre-management abundance. Preliminary results indicate that this survey will be a successful monitoring tool for the Delaware Bay sand tiger shark population and for evaluating long-term changes in abundance and size composition. Staff also collaborated with scientists from Delaware State University and the University of Rhode Island on an automated acoustic telemetry study to quantify residence time and fine-scale habitat use of sand tiger sharks in the Bay.

f) Marine Mammals

Small Cetaceans: Between 31 July and 30 August 2007, a joint shipboard and aerial survey was conducted from the coastline to the 2000m depth contour between Cape Hatteras, NC and the northern Bay of Fundy.

The primary objective was to determine the spatial distribution and abundance of cetaceans, sea turtles, and seabirds in the region. On the shipboard survey (using the *FSV Henry B. Bigelow*), additional objectives included use of passive acoustics to record vocalizing cetaceans, and oceanographic sampling (e.g., CTD and bongo casts) to help define habitats throughout the survey region. An acoustic sensor array, containing two high-frequency elements and three medium frequency elements, was towed 200-300m behind the ship.

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 2007 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: During 19 July - 9 August 2007, investigators a marine mammal survey was conducted in the Gulf of Maine using the R/V *Delaware II*. Most survey effort focused on oceanographic sampling of known North Atlantic right whale (*Eubalaena glacialis*) habitats (i.e., the northern edge of Georges Bank, the southwest part of Georges Bank, and Roseway Basin). Other objectives included humpback whale (*Megaptera novaeangliae*) photo-ID, and pilot whale biopsy and photogrammetric work.

A joint NEFSC / Woods Hole Oceanographic Institution right whale tagging and habitat sampling survey was conducted in May 2007 to investigate right whale foraging ecology in the Great South Channel area off Massachusetts, USA. This was the fourth consecutive year of this joint project.

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. Four primary types of surveys were flown in 2007: (1) broadscale; (2) focused surveys in the Great South Channel (GSC) Critical Habitat; (3) focused surveys over potential and realized Dynamic Area Management (DAM) closure zones; and (4) focused surveys in a designated Navy bombing range located over Cashes Ledge, referred to as W-104B. Broadscale surveys were flown along systematic east-west tracklines, which covered all Federal waters west of the Hague Line (from south of Long Island, New York to Eastport, Maine). These surveys were conducted to provide a synoptic view of right whale distribution. Surveys focused on the GSC served the dual purpose of providing relatively current locations of right whale aggregations to commercial shipping traffic, and to obtain high photographic recapture rates of individuals for vital rate models of the population. DAM confirmation flights were designed to investigate reported sightings of right whale aggregations outside existing closures, as well as for monitoring the duration of residence of aggregations in established DAM zones. Focused surveys in W-104B were conducted in cooperation with the Navy prior to scheduled bombing exercises to determine the presence/absence of marine mammals and sea turtles. Additional focused flights were made to relocate reported whale carcasses or entangled whales, and provide support for disentanglement efforts. A total of 66 flights were made in 2007. 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 840.

During 2 January - 1 March 2007, 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.

A 14 month large-scale passive acoustic study conducted in the Stellwagen Bank National Marine Sanctuary concluded in early 2007. The project involved collaboration between NMFS, the Sanctuary Office, and Cornell University. Ten passive acoustic recording units, which were deployed and retrieved every three months, recorded all biological and anthropogenic sounds between 5 and 1000Hz. Analyses are underway of the acoustic distribution and occurrence of right whales, humpback whales, fin whales (*Balaenoptera physalus*) and selected fish species. Project details are available at: http://stellwagen.noaa.gov/science/passive_acoustics.html. Anthropogenic noise and vessel movements are now being mapped relative to biological activity and occurrence. This study led to the award of a 3-year National Oceanographic Partnership Program grant for 'developing an ocean observing system for large-scale monitoring and mapping of ocean noise throughout the Stellwagen Sanctuary'. This latter investigation was initiated in October 2007 and will continue into 2010.

Scarification analyses of right and humpback whales continued in 2007. 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 2007, 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 gray seal recolonization and pup production in New England waters continued in 2007. A total of 13 aerial seal surveys were accomplished, 9 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 2007, research efforts were focused on Mid-Atlantic bottom trawl fisheries, Mid-Atlantic sea scallop (dredge and trawl) fisheries, and Mid-Atlantic gillnet fisheries.

In the Atlantic sea scallop fishery, NEFSC staff conducted both bycatch analyses and gear research. Observed turtle interactions with commercial vessels in the U.S. sea scallop dredge (2005) and trawl (2004 and 2005) fisheries were used to estimate bycatch of loggerhead sea turtles (*Caretta caretta*) in the mid-Atlantic region. In addition, NEFSC continued to work with the scallop fishing industry to further modify and test a scallop dredge designed to reduce the likelihood of sea turtle injuries during commercial scalloping operations.

3. Studies of Fishing Operations

In 2007, NEFSC observers were deployed on 2,989 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 195 marine mammal incidental takes, 41 sea turtle incidental takes, and 180 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. Tissue samples were collected from many of these animals, and often the entire animal collected when possible.

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

In the sink anchored gillnet fishery, 857 trips were observed with a total of 3,585 gear retrievals. There

were 156 observed marine mammal takes in this fishery (80 gray seals, 35 harbor porpoises, 18 unidentified seals, 12 harp seals, 6 harbor seals, 2 unidentified porpoise/dolphins, 1 Risso's dolphin, 1 common dolphin and 1 unidentified toothed whale). There were also 121 seabird takes observed in this fishery.

b) Float Drift Gillnet Fishery

In the float drift gillnet fishery, 49 trips were observed with a total of 144 gear retrievals. No marine mammal, sea turtle, or seabird takes were observed in this fishery.

c) Otter Trawl Fisheries

In the bottom otter trawl fishery, 1,120 trips were observed with a total of 14,848 gear retrievals. In addition, there were 3 twin trawl trips with 23 gear retrievals, 18 midwater trawl trips with 49 gear retrievals, 37 scallop trawl trips with 38 gear retrievals, and 14 shrimp bottom otter trawl trips with 60 gear retrievals. In the bottom otter trawl fishery, there were 32 observed marine mammal takes (10 gray seals, 5 Atlantic white-sided dolphins, 5 pilot whales, 3 common dolphins, 3 harbor seals, 2 unidentified marine mammals, 1 harbor porpoise, 1 unidentified porpoise/dolphin, 1 unidentified seal, and 1 unidentified whale). There were also 26 loggerhead turtle, 1 Kemp's ridley and 1 leatherback turtle takes, and 13 seabird takes in this fishery. No marine mammal, sea turtle or seabird takes were observed in the twin trawl fishery. In the mid-water trawl fishery, there was 1 Atlantic white-sided dolphin, 1 common dolphin, and 1 pilot whale taken. In the scallop trawl fishery, there were 5 loggerhead turtle and 1 unidentified hard-shell turtle 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, 366 trips were observed with a total of 24,606 gear retrievals. There were 4 loggerhead turtle, 1 Kemp's ridley turtle and 7 seabird takes observed in this fishery.

e) Conch Pot Fishery

No conch pot trips were observed in 2007.

f) Scottish Seine Fishery

No Scottish seine trips were observed in 2007.

g) Sink Drift Gillnet Fishery

In the sink drift gillnet fishery, 331 trips were observed with a total of 2,036 gear retrievals. There were 2 observed marine mammal (1 harbor porpoise and 1 humpback whale), 1 leatherback turtle and 5 seabird takes in this fishery.

h) Anchored Floating Gillnet Fishery

In the anchored floating gillnet fishery, 7 trips observed with a total of 9 gear retrievals. No marine mammal, sea turtle, or seabird takes were observed in this fishery.

i) Mid-water Pair Trawl Fishery

In the mid-water pair trawl fishery, 30 trips were observed with a total of 53 gear retrievals. No marine mammal or sea turtle takes were observed in this fishery. There were 30 seabird takes observed in this fishery.

j) Bottom Longline Fishery

In the bottom long line fishery, 92 trips were observed with a total of 461 gear retrievals. There was 1 unidentified seal and 3 seabird takes observed in this fishery.

k) Beach Haul Seine Fishery

In the beach haul gillnet fishery, 27 trips were observed with a total of 27 gear retrievals. There was 1 Kemp's ridley take observed in this fishery. No marine mammal or seabird takes were observed.

l) Pound Net Fishery

No pound net trips were observed in 2007.

m) Handline Fishery

In 2007, 1 handline trip was observed with 3 gear retrievals, and 2 trolling trips observed with 6 gear retrievals. No marine mammal, sea turtle or seabird takes were observed on these trips..

n) Herring Purse Seine Fishery

There were 15 herring purse seine trips with 28 gear retrievals observed in 2007. There was 1 unidentified seal take observed in this fishery. No sea turtle or seabird takes were observed in this fishery.

o) Menhaden Purse Seine Fishery

There were 2 menhaden purse seine trips with 2 gear retrievals observed in 2007. No marine mammal, sea turtle or seabird takes were observed in this fishery.

p) Lobster Pot Fishery

No lobster pot trips were observed in 2007.

q) Fish Pot Fishery

In 2007, 7 hagfish pot fishing trips were observed, with a total of 79 gear retrievals. No marine mammal, sea turtle or seabird takes were observed in this fishery.

r) Conch Pot Fishery

One conch pot trip with 94 gear retrievals was observed in 2007. No marine mammal, sea turtle or seabird takes were observed in this fishery.

s) Red Crab Pot Fishery

In 2007, 2 red crab pot fishing trips were observed with 43 gear retrievals. No marine mammal, sea turtle or seabird takes were observed in this fishery.

t) Clam Dredge Fishery

In the clam dredge fishery, 4 trips were observed in 2007 with a total of 138 gear retrievals. No marine mammal, sea turtle or seabird takes were observed in this fishery.

4. Population Dynamics Research

a) Atlantic Salmon Research

Atlantic salmon in eight rivers of 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. 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 2007 focused on obtaining smolt production estimates 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. Investigations were undertaken to examine the feasibility of monitoring smolt emigration through non-invasive sampling with the Dual Frequency Identification Sonar technology (Didson). A large hatchery smolt tagging program has provided information useful in characterizing smolt emigration and adult returns in relation to stocking practices. Preliminary results from these studies indicate differential migration success in relation to stocking location and time. The effect that stocking location and time have on marine survival will also be evaluated via subsequent adult returns of marked hatchery fish. 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) are being investigated through follow-up studies. Monitoring the West Greenland fishery and collecting biological data and fishery statistics continued as well. 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) Study Fleet

The Northeast Fisheries Science Center (NEFSC) administers and coordinates a cooperative research program in the northeastern USA in which commercial fishing vessels provide more accurate, detailed (temporally and spatially), and comprehensive data. This study fleet concept focuses on using electronic reporting mechanisms for recording haul-based data, as compared to trip or sub-trip paper records typical of vessel logbooks in the northeast. Study fleet vessels are equipped with an electronic logbook (ELB) system that allows fishermen to record fisheries-dependent information at scales equivalent to those in the Northeast Fishery Observer Program (NEFOP). The ELB system comprises: (a) a laptop computer with ELB software installed, fishermen enter trip, effort, and catch information; (b) a gear-mounted temperature-depth (TD) probe; and (c) laptop integration with existing vessel electronics (global positioning system (GPS), vessel monitoring system (VMS) and depth sounder). Study fleet fishermen receive training on the use of the ELB system and on proper catch reporting protocols.

A stable electronic recording system has been developed and field tested. Fishermen enter trip, haul, and catch information into the ELB software, which provides detailed haul-by-haul information on the location and timing of commercial catches. At the end of a trip, ELB trip data files are transmitted to the NEFSC using a vessel's existing Vessel Monitoring System (VMS); raw trip data are typically available for audit within two hours of the end of a trip. The polling rates of a vessel's GPS feed and that of the temperature depth probe can be adjusted according to study requirements; typical settings are 20 seconds and 1:30 minutes respectively. Monthly visits to each vessel allow field scientists to collect the large GPS data files, TD probe data and maintain an interactive relationship with fishermen. Post-processing of these data provide high-resolution information on the location, timing and duration of fishing effort, and the resulting catches.

The Study Fleet Pilot Program (phases I, II) focused on software development, satellite communications and rigorous testing. Analyses of catch data collected in these phases indicated that while Study Fleet catch data represented an improvement over that provided in the mandatory paper logbooks, fishing vessel trip reports (VTRs); the data were still not comparable to the data collected by the NEFOP. To address this shortcoming, Phase III activities were initiated in September 2005 and have focused on working cooperatively with six (6) study fleet participants to refine and finalize standard recording protocols for self-reported study fleet fisheries data. Field personnel have conducted initial time-in-motion studies to observe the flow of fishing operations onboard various vessels and have discussed viable catch sampling and sub-sampling procedures with captains and crew. Additionally, field scientists have performed baseline catch sampling that can be compared to the fishermen's self-recorded estimates. The level of agreement between technician and self-reported catch data is being used to establish a baseline with which to asses the efficacy of any standard protocols which will be implemented.

Limited deployments in 2007/2008 have concentrated on small, data-poor fisheries which lack sufficient observer coverage in an attempt to improve estimates of fishing effort used in stock assessments. Software utility is limited in fixed gear fisheries with overlapping trips (previously deployed gear is hauled then reset and left to soak). However, these limitations will be addressed in the next software version which is currently under development.

Developmental work has begun on the integration of radio frequency identification (RFID) tag technology to improve the accuracy of long line gear deployment estimates. The use of RFID tags deployed at regular intervals along a main line will lead to more accurate and precise estimates of main line length and hook counts. Current development is proceeding with cooperation from four tilefish permit holders and aims to improve the catch per unit effort (CPUE) estimates of this data poor fishery. The data provided for current assessment methods result in a single CPUE estimate per trip. RFID integration will allow CPUE estimates to be determined on a daily or possibly a haul by haul basis.

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. A total of 16 packages are now included in the toolbox. Additional modules are under development. The population simulator has been enhanced to allow for model testing with multiple stochastic realizations of simulated datasets containing the same error structure for multiple models. The complete package may be accessed at http:/nft.nefsc.noaa.gov (note that a password is no longer required).

In 2007, the NFT website was significantly upgraded to improve the ability to locate and compare software packages. The new look and feel of the website is more pleasing as well. Version numbers and dates of most recent update allow quick determination of the most recent version of a software package. Enhanced graphic and data entry features have also been added to most programs. A new statistical catch at length program (SCALE) has been added and a major update to ASAP and SS2 have also been made. The programs available continue to be updated and new programs are expected in 2008, including a length-based approach to estimate total mortality and a combination of packages to allow Management Strategy Evaluations.

d) Biological Studies

Ongoing sea scallop research at NEFSC includes analyses of spatial management measures including both rotational and long-term closures, analysis of sea scallop growth, optical methods of enumerating scallops and other benthic invertebrates, environmental predictors of recruitment, and dynamic length-based stock assessment models.

e) Tagging Studies

In 2003, a yellowtail flounder cooperative tagging program was initiated by the Northeast Fisheries Science Center (NEFSC) to address some of the major sources of uncertainty in the yellowtail flounder assessments. Using both conventional disc tags and archival tags, the study is designed to estimate: (a) movements of yellowtail among stock areas; (b) mortality of yellowtail within stock areas; and to (c) monitor yellowtail growth rates.

A comprehensive outreach system (including reward posters, brochures, websites (http://www.cooperative–tagging.org), annual letters to yellowtail fishermen, press releases, and a toll free number (1-877-826-2612)) is used to improve reporting of tags from the commercial fishery. Rewards for reporting tags include $1000 lottery tags, $100 high-reward tags, and $100 for data-storage tags. Every fisherman reporting a recapture is contacted via phone and is sent a 'thank you' letter with a map detailing the movements of the tagged fish. Additionally, fishermen returning data-storage tags receive $100, and are also provided with the temperature and pressure profile plots from the data-storage tag.

All of the tagging and tag-recapture data are loaded into a fully-relational database (maintained by the NEFSC) which has the capability to quickly summarize the data in various ways and to generate GIS maps.

To date, over 45,000 tags have been released with more than 3,600 reported recaptures. Eight percent of all lottery tags have been returned, including 13% of the $100 high-reward tags and 10% of the data-storage tags. The relative return rate of lottery to high-reward tags implies a 59% reporting rate, which is exceptional for a commercial fishery. Preliminary analyses of recaptured tags show frequent movements within the Cape Cod and Georges Bank stock areas, with less frequent movements among stock areas. The recapture data indicate: (a) 96% residence in the Cape Cod-Gulf of Maine stock area (with 3% movement to Georges Bank and 1% movement to Southern New England-Mid Atlantic); (b) 98% residence in the Georges Bank stock area (with 1% movement to Cape Cod-Gulf of Maine and 1% movement to Southern New England-Mid Atlantic); and (c) 47% residence in Southern New England-Mid Atlantic area (with 39% movement to Georges Bank and 14% movement to Cape Cod-Gulf of Maine).

Until recently, yellowtail flounder were thought to be a "sedentary" species, feeding on epibenthic fauna and residing in relatively shallow, sandy habitats. However, the information collected from the data-storage tags (n = 60) has revealed distinct off-bottom movements. These off-bottom movements typically occurred during evening hours between 18:00 and 22:00, lasting an average of four hours, with the fish ascending to an average of 15m off-bottom. The frequency of off-bottom movements differed geographically, averaging once every ten days in the Cape Cod-Gulf of Maine area and once every three days on Georges Bank. This suggests that the movement patterns inferred from the tag returns of the disc-tagged yellowtail likely indicate passive drift in mid-water currents, similar to the movement behavior observed in other flatfish species.

Although many tagged yellowtail flounder are still at large and recaptures continue to be reported, analytical approaches (i.e. movement-mortality modeling and simulation studies) are now being explored to determine the most appropriate model structures for incorporating the tagging study results into future yellowtail flounder stock assessment analyses.

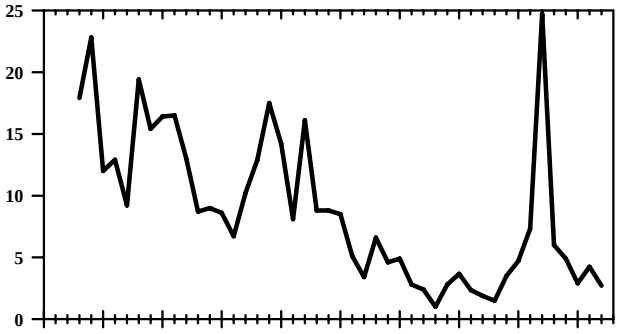

Figure 1. NEFSC autumn bottom trawl survey biomass indices for Gulf of Maine cod.

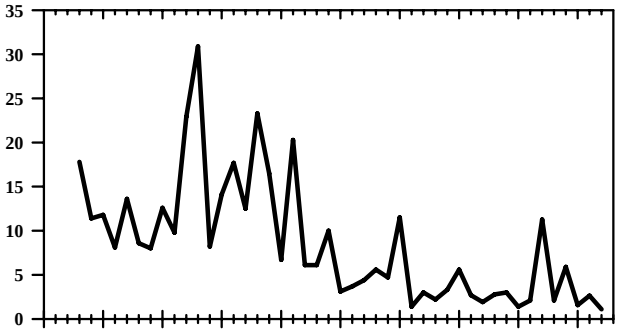

Figure 2. NEFSC autumn bottom trawl survey biomass indices for Georges Bank cod.

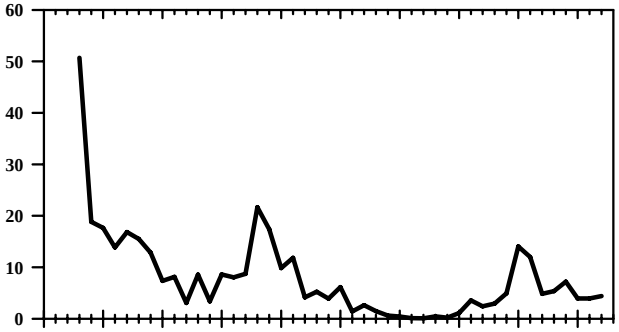

Figure 3. NEFSC autumn bottom trawl survey biomass indices for Gulf of Maine haddock.

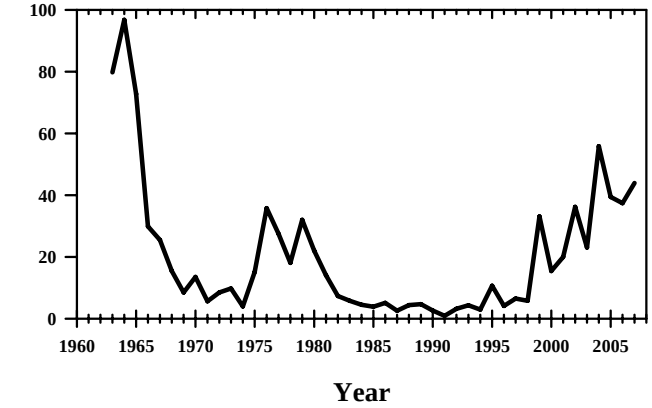

Figure 4. NEFSC autumn bottom trawl survey biomass indices for Georges Bank haddock.

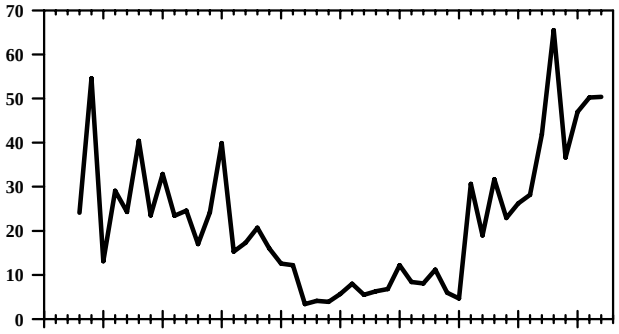

Figure 5. NEFSC autumn bottom trawl survey biomass indices for redfish.

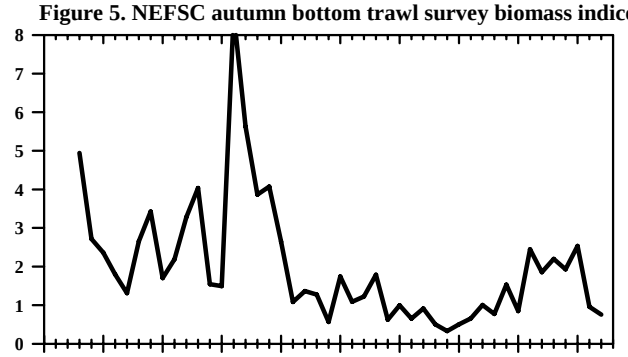

Figure 6. NEFSC autumn bottom trawl survey biomass indices for pollock.

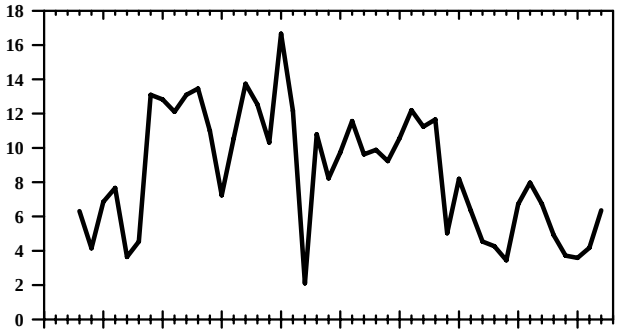

Figure 7. NEFSC autumn bottom trawl survey biomass indices for white hake.

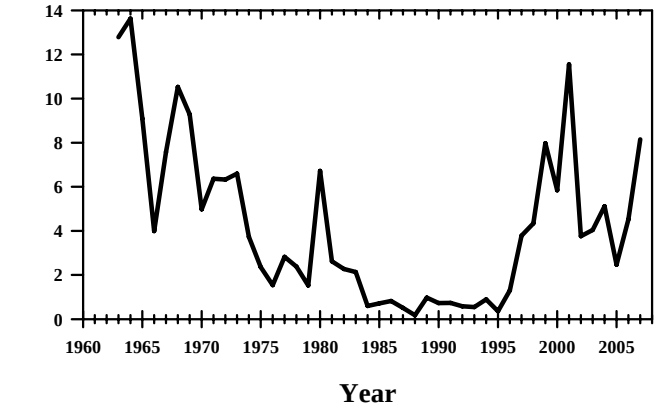

Figure 8. NEFSC autumn bottom trawl survey biomass indices for Georges Bank yellowtail flounder.

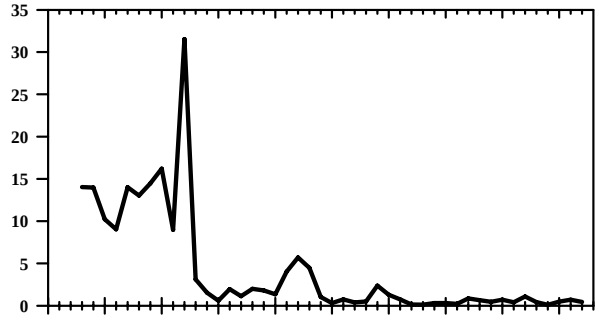

Figure 9. NEFSC autumn bottom trawl survey biomass indices for Southern New England-Mid-Atlantic yellowtail flounder.

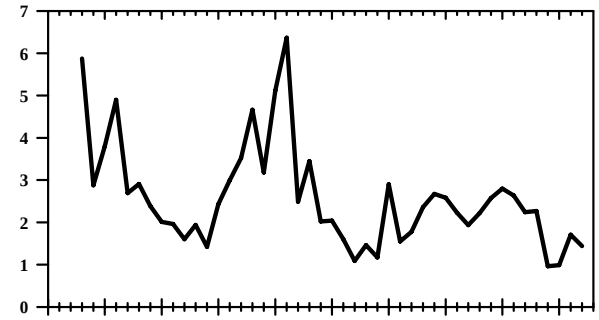

Figure 10. NEFSC autumn bottom trawl survey biomass indices for American plaice.

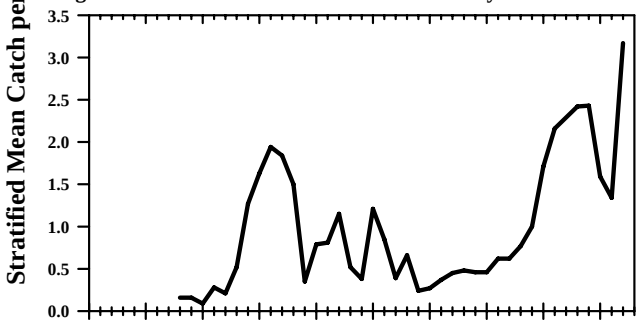

Figure 11. NEFSC spring bottom trawl survey biomass indices for summer flounder.

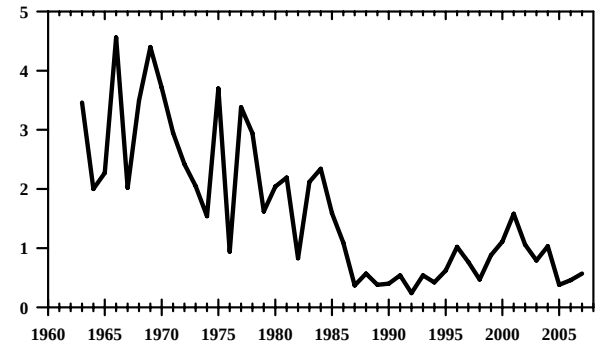

Figure 12. NEFSC autumn bottom trawl survey biomass indices for witch flounder.

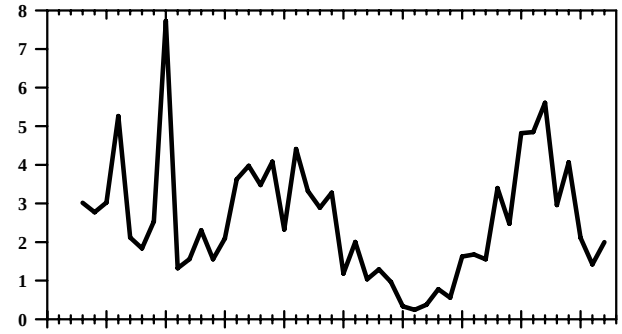

Figure 13. NEFSC autumn bottom trawl survey biomass indices for Georges Bank winter flounder.

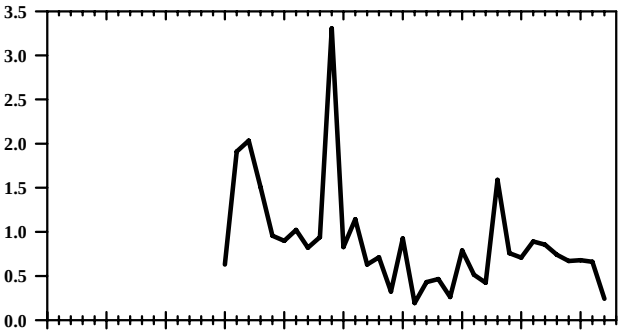

Figure 14. NEFSC autumn bottom trawl survey biomass indices for northern windowpane flounder.

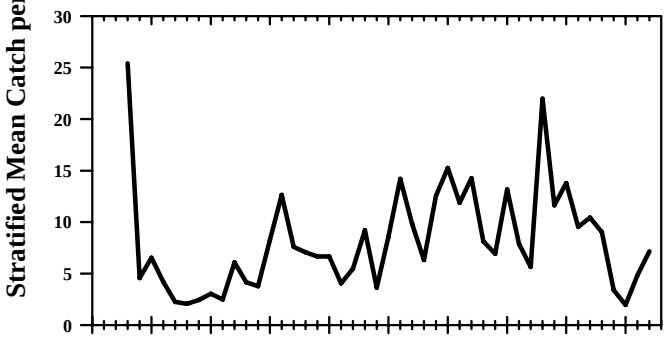

Figure 15. NEFSC autumn bottom trawl survey biomass indices for northern silver hake.

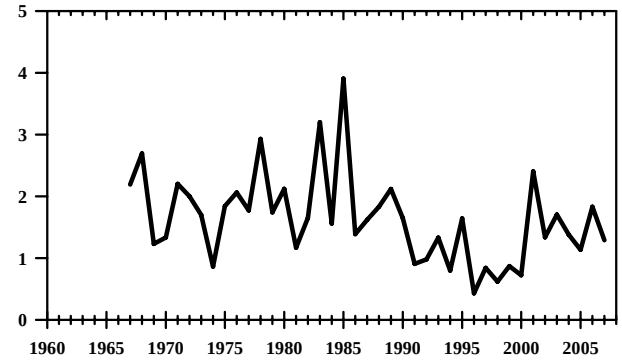

Figure 16. NEFSC autumn bottom trawl survey biomass indices for southern silver hake.

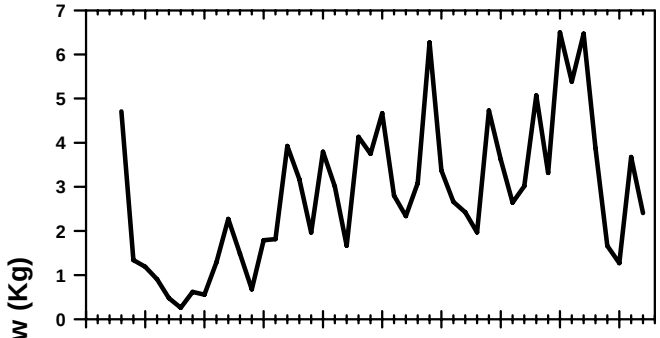

Figure 17. NEFSC autumn bottom trawl survey biomass indices for northern red hake.

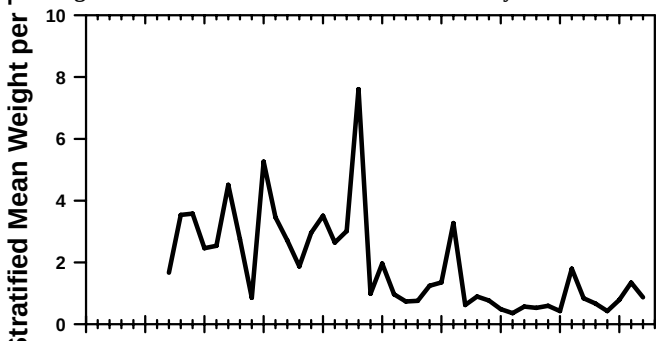

Figure 18. NEFSC autumn bottom trawl survey biomass indices for southern red hake.

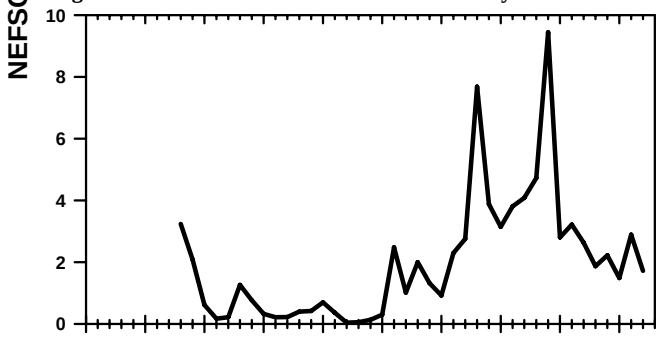

Figure 19. NEFSC spring bottom trawl survey biomass indices for Atlantic herring.

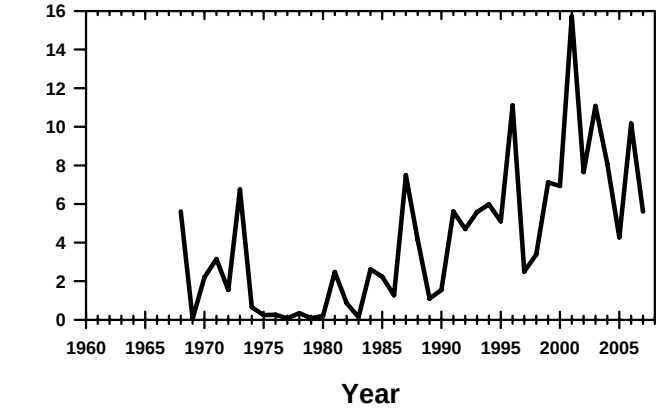

Figure 20. NEFSC spring bottom trawl survey biomass indices for Atlantic mackerel.

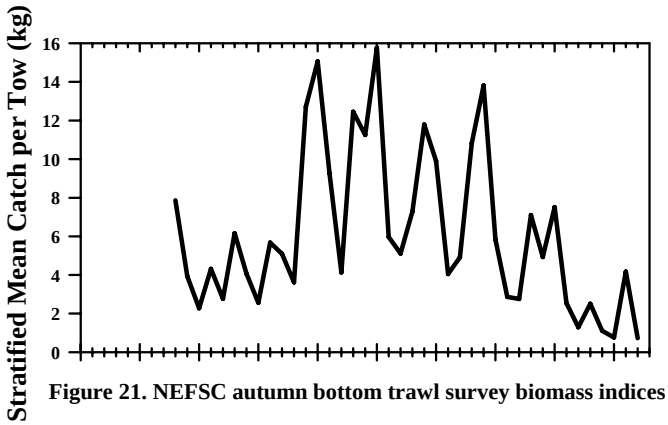

Figure 21. NEFSC autumn bottom trawl survey biomass indices for butterfish.

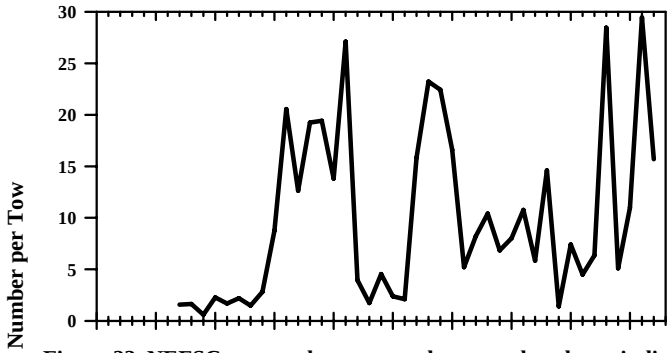

Figure 22. NEFSC autumn bottom trawl survey abundance indices for *Illex*.

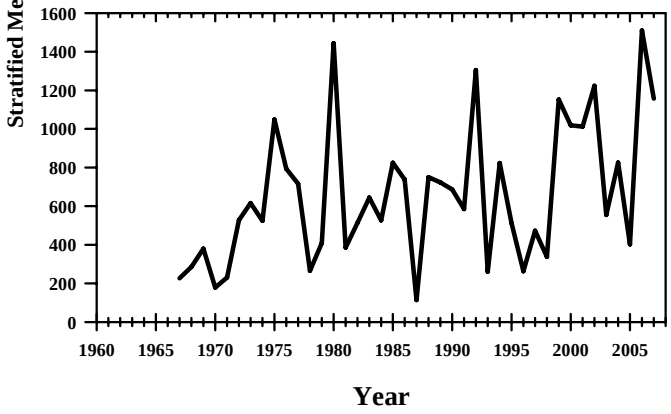

Figure 23. NEFSC autumn bottom trawl survey abundance indices for *Loligo*.

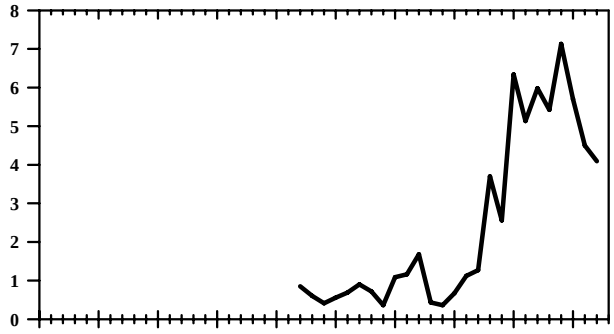

Figure 24. NEFSC scallop survey biomass indices for Georges Bank sea scallops.

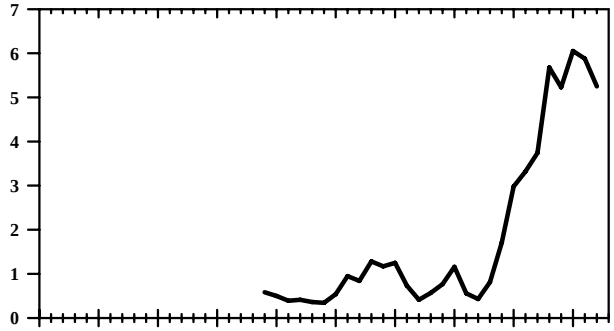

Figure 25. NEFSC scallop survey biomass indices for Mid-Atlantic Bight sea scallops.

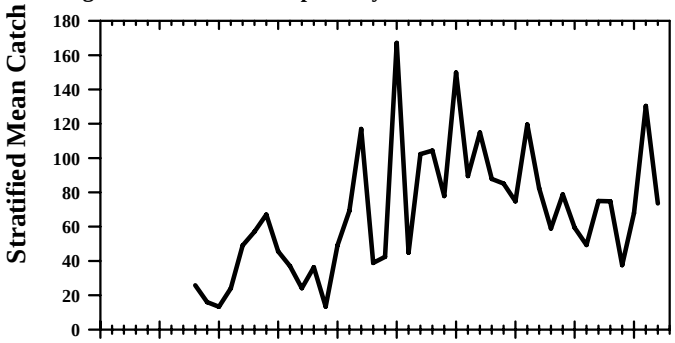

Figure 26. NEFSC spring survey biomass indices for spiny dogfish.

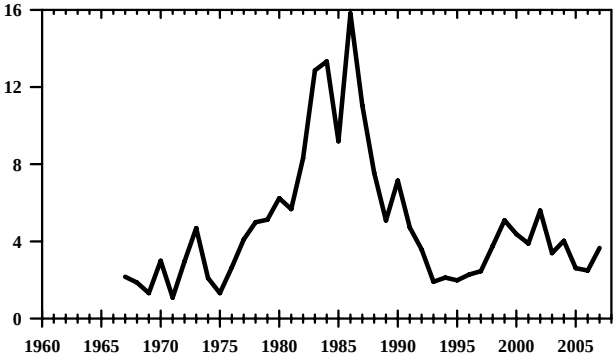

Figure 27. NEFSC autumn survey biomass indices for winter skate.

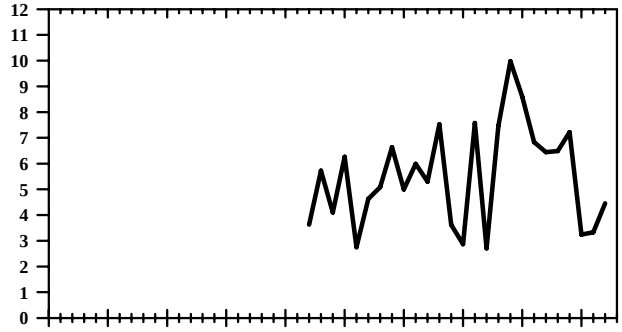

Figure 28. NEFSC spring survey biomass indices for little skate.

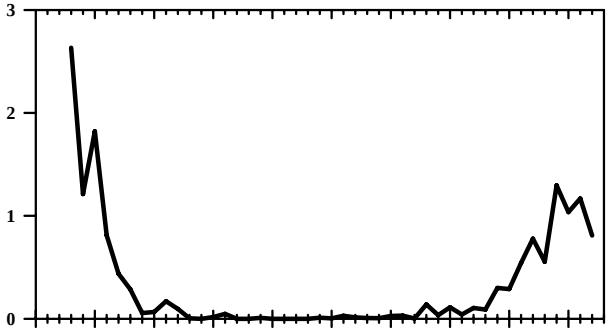

Figure 29. NEFSC autumn survey biomass indices for barndoor skate.

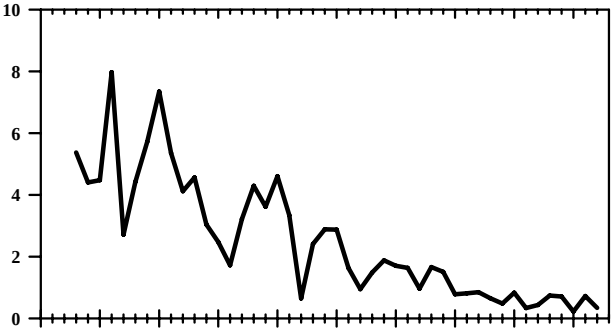

Figure 30. NEFSC autumn survey biomass indices for thorny skate.

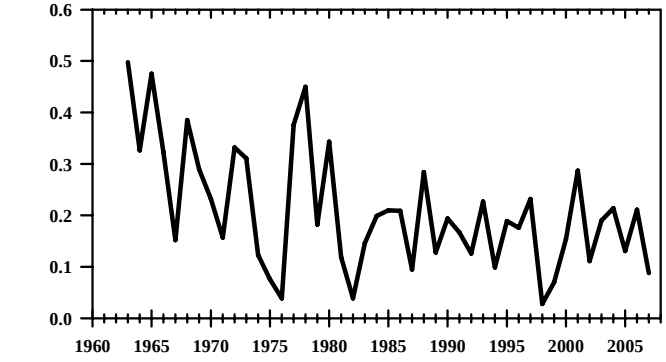

Figure 31. NEFSC autumn survey biomass indices for smooth skate.

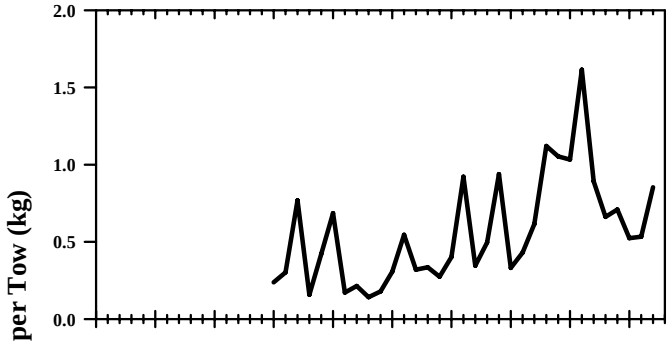

Figure 32. NEFSC autumn survey biomass indices for clearnose skate.

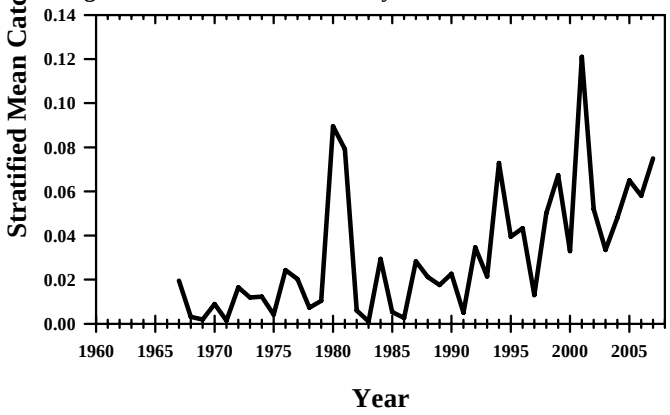

Figure 33. NEFSC autumn survey biomass indices for rosette skate.