

**SCIENTIFIC COUNCIL MEETING – JUNE 2007**

United States Research Report for 2006

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.

1. Atlantic Cod

USA commercial landings of Atlantic cod (*Gadus morhua*) from Subareas 5-6 in 2006 were 5,705 mt, a 10% decrease from 2005 landings of 6,327mt and a 22% decrease from the 7,287 mt landed in 2004.

USA cod landings from the Gulf of Maine (Div. 5Y) in 2006 were 3,165 mt, a 19% decrease from 3,909 mt landed in 2005. 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. Although the autumn survey index increased between 2005 and 2006, it is among the lowest in the survey series (Figure 1).

USA cod landings from Georges Bank (Div. 5Z and SA 6) in 2006 were 2,540 mt, a 5% increase from 2,418 mt landed in 2005 and a 36% decrease from 3,470 mt landed in 2004. NEFSC research vessel survey biomass indices remained near record-low levels during 1991-2005, with the exception of an increase in 2002, due primarily to a large catch at one station, and an increase in 2004 as a result of three large tows in three separate strata. The index increased in 2006 from 2005 index but is still near the record-low (Figure 2).

2. Haddock

USA haddock (*Melanogrammus aeglefinus*) landings decreased 59% from 7,581 mt in 2005 to 3,266 mt in 2006. Georges Bank (Div. 5Z) haddock landings decreased 59% from 6,107 mt in 2005 to 2,475 mt in 2006. Gulf of Maine (Div. 5Y) haddock landings decreased by 45% between 2005 and 2006 from 1,435 mt to 791 mt. Landings from both stocks are below historical levels.

Research vessel survey biomass indices decreased in 2006 for the Gulf of Maine stock but increased in the Georges Bank stock (Figures 3 and 4). Stock biomass of Georges Bank haddock had increased sharply in recent years due to recruitment of the exceptional 2003 year class.

3. Redfish

USA landings of Acadian redfish (*Sebastes fasciatus*) decreased by 12% from 564 mt in 2005 to 499 mt in 2006. 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 in 2003, 2005 and 2006 are among the highest observed in the survey series.

4. Pollock (4VWX + 5 stock)

USA landings of pollock (*Pollachius virens*) decreased by 7% from 6,521 mt in 2005 to 6,058 mt in 2006. 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, however, the biomass index declined sharply.

5. White Hake

USA landings of white hake (*Urophycis tenuis*) decreased by 37% from 2,680 mt in 2005 to 1,695 mt in 2006. 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 (Figure 7).

6. Yellowtail Flounder

USA landings of yellowtail flounder (*Limanda ferruginea*) decreased 53% from 4,118 mt in 2005 to 1,933 mt in 2006. 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 2006 totaled 12,074 mt, 22% lower than in 2005. Summer flounder (*Paralichthys dentatus*) (52%), winter flounder (*Pseudopleuronectes americanus*) (23%), witch flounder (*Glyptocephalus cynoglossus*) (15%), American plaice (*Hippoglossoides platessoides*) (9%), and windowpane flounder (*Scophthalmus aquosus*) (1%) accounted for virtually all of the 'other flounder' landings in 2006. Compared to 2005, commercial landings in 2006 were higher for windowpane flounder (18%) but lower for winter flounder (-25%), American plaice (-18%), witch flounder (-30%) and summer flounder (-20%). Research vessel survey indices in 2006 increased for American plaice, decreased for summer flounder, windowpane flounder and winter flounder, and remained relatively constant for witch flounder (Figures 10-14).

8. Silver hake

USA landings of silver hake (*Merluccius bilinearis*) decreased by 24% from 6,813 mt in 2005 to a record low of 5,181 mt in 2006. Research vessel survey biomass indices for the Gulf of Maine - Northern Georges Bank stock varied without trend during 1990-1997, 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 (Figure 16).

9. Red Hake

USA landings of red hake (*Urophycis chuss*) increased 19% from a record low of 315 mt in 2005 to 374 mt in 2006. 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, but increased in 2006 (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 4% from 93,443 mt in 2005 to 97,241 mt in 2006. Commercial landings from Georges Bank decreased 64 % from 13,397 mt in 2005 to 4,883 mt in 2006. Spring survey indices increased greatly in the 1990s, dropped in 2000, and have remained in a range between 2-3 kg/tow during 2001-2006 (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*) increased 36% from 41,677 mt in 2005 to 56,637 mt in 2006. Recreational catch increased 57% from 1,042 mt in 2005 to 1,631 mt in 2006. Spring survey indices increased steadily during the 1990s and have averaged over 9 kg/tow during 2000-2006 (Figure 20) Spawning stock biomass in 2005 was estimated at 2.5 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 23% from 434 mt in 2005 to 535 mt in 2006. Research vessel survey biomass indices increased during the late 1970s, fluctuated during the 1980s, declined to record-low values during 2001-2005, but increased in 2006 (Figure 21).

13. Squids

USA landings of northern shortfin squid (*Illex illecebrosus*) during 2006 were 13,943 mt, 16% higher than in 2005 (12,032 mt). The NEFSC autumn survey relative abundance index reached a record high (29.5 squid per tow) during 2006 (Figure 22), and the average weight of individual squid caught in the survey increased from 67 g in 2005 to 99 g in 2006.

USA landings of longfin inshore squid (*Loligo pealeii*) during 2006 were 15,950 mt, 6% lower than in 2005 (16,987 mt). The NEFSC autumn survey abundance index was the highest on record in 2006 (Figure 23).

14. Sea Scallops

USA sea scallop (*Placopecten magellanicus*) landings in 2006 were 26,704 mt (meats), a slight increase over the 2005 level. About 65% (17,286 mt) of the 2006 landings were taken from Georges Bank; a majority of the Georges Bank landings were from reopened portions of the groundfish closed areas. Average annual U.S. landings during 2002-2006 (26,006 mt) were more than twice the long-term fifty-year (1957-2006) average.

Research vessel survey indices in 2006 indicated continued high biomass in both the Georges Bank and Mid-Atlantic regions (Figures 24 and 25). A majority of the Georges Bank biomass remains in the groundfish closed areas which have also been closed to scallop fishing for most of the time since 1994. Similarly, the majority of the Mid-Atlantic biomass is in a rotational area off of New Jersey and Delaware (the Elephant Trunk area) that was closed to scallop fishing in 2004 because of small scallops (good

recruitment) in this area. Overall, recruitment in 2006 was below average in the U.S. portion of Georges Bank, and about average in the Mid-Atlantic.

15. Small Elasmobranchs

USA landings of spiny dogfish (*Squalus acanthias*) increased by 96% from 1,147 mt in 2005 to 2,249 mt in 2006. Survey indices are highly variable but generally declined from the early 1990s through 2005, although the index increased sharply in 2006 (Figure 26).

USA landings of skates (80% landed as unclassified) increased by 15% between 2005 and 2006 from 14,113 mt to 16,180 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 have since 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 1950 CTD (conductivity, temperature, depth) profiles were accomplished on NEFSC cruises during 2006. The data from these cruises are accessible at <http://www.nefsc.noaa.gov/epd/ocean/MainPage/>. This site includes access to records on CTD, moored bottom-temperature, drifters, trawl surveys, and along-track hull-mounted sensor measurements. Most notably, users can access area-averaged temperature and salinity data for various regions of the shelf, including the anomalies relative to historical data. Reports of the oceanographic conditions indicated by these observations are available at: ftp://ftp.nefsc.noaa.gov/pub/hydro/cruise_rpts/2006/.

b) Plankton Studies

During 2006, zooplankton community distribution and abundance were monitored using 674 bongo net tows taken on seven 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 thirteen transects across the Gulf of Maine from Cape Sable, NS to Boston and seven transects across the mid-Atlantic Bight from New York to the Gulf Stream during the same time period.

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 describe habitats and determine habitat effects of mobile fishing gears in New England and Mid-Atlantic waters. An August 2006 cruise had two objectives. First, a long-term study of fishing gear effects was continued by re-sampling gravel habitats on northern Georges Bank in an area which was closed to fishing in 1994. Sites inside the closed area continued to have an increased abundance of taxa sensitive to bottom fishing disturbance, including sea urchins and horse mussels. Emergent epifauna such as sponges and bryozoans

are still present but, as seen in the 2005 August survey, are less abundant than in the years immediately following the closure. The sediment in the area was much sandier than in previous years, and the sand may have inhibited epifaunal growth. Sites outside the closed area continued to appear heavily disturbed, and the bottom remains mostly bare gravel. The second objective was to monitor the distribution, abundance, and ecological impacts of an invasive tunicate, *Didemnum* sp. The tunicate had about the same areal distribution as in summer 2005, being abundant over at least 61 square miles of gravel substrate in an area open to fishing on northern Georges Bank, and 21 sq. mi. in an adjacent area closed to fishing. In both areas, the colonies had increased in number and size since 2005; at some sites they covered more than 75% of the seabed. These gravel beds are considered highly productive for fish and scallops, and the tunicate infestation is thought to be unique, the only known occurrence of this magnitude in a major offshore fishing ground. The benthic community composition is changing in areas where the tunicate is abundant – most notably, two polychaete species are substantially more numerous in those areas than elsewhere. Tunicate samples were collected for taxonomic studies and to determine fatty acid signatures, nutritive values, and desirability as prey to several generalist bottom feeders.

Analyses of the potential food value of *Didemnum* sp. were performed at the Howard Laboratory, and suggest that the food value is small compared with other benthic organisms. *Didemnum* sp. possess a high and variable content of indigestible matter (average ash content exceeding 60% of dry weight) and relatively low nutritive value (average protein content less than 20%).

A considerable area of bottom on Georges Bank has become dominated by the tunicate, apparently excluding or inhibiting access to other benthic food sources. Haddock and winter flounder from the area were found with undigested tunicates in their stomachs. Experiments to identify potential predators of *Didemnum* demonstrated the palatability of the *Didemnum* to three common marine invertebrates: the purple sea urchin (*Arbacia punctulata*), common spider crab (*Libinia emarginata*), and the Asian shore crab (*Hemigrapsus sanguineus*) when no alternative food was offered. Cunner (*Tautoglabrus adspersus*), a local wrasse, did not ingest the tunicate.

These results suggest that a large area of the productive Georges Bank ecosystem may have been devalued as demersal fish habitat, but if a predator of *Didemnum* emerges, a new balance could eventually be established where *Didemnum* becomes less dominant, and hence less influential.

Inshore studies of habitat requirements of resource species and fishing gear effects on habitat were continued. In an area with 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 population is reestablished fairly rapidly. A cooperative project was continued in 2006 to restore oyster reefs in local estuaries and determine functional value of the reefs to resource species. A Biological Review Team completed assembly of information for determining whether the eastern oyster, *Crassostrea virginica*, should be listed as a threatened or endangered species. However, the petition to list the oyster was later withdrawn. A paper on effects of sewage sludge disposal on the benthos of the inner New York Bight is now in press (Mar. Ecol. Prog. Series). The series of “Essential Fish Habitat Source Documents”, which summarize information on the ~40 resource species managed by the New England and Mid Atlantic fishery management councils was completed. Other ongoing projects are to 1) examine relationships between springtime weather patterns and success of bivalve recruitment over the past two decades, and 2) synthesize information on biology, ecology and fisheries for the bay scallop, *Argopecten irradians*.

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 for evaluating the aquacultural potential of a species. During 2005-06 an experiment was conducted using winter flounder, *Pseudopleuronectes americanus*, to evaluate the relative contributions of paternal, maternal, and thermal contributions to early

life-history traits of winter flounder offspring. Responses were scored from embryonic development through larval life and into juvenile life-stage, culminating with gender expression. Preliminary results show the relative ranking of families (sib-groups) with respect to their growth and developmental rates to environmental changes. Such environmental dependency affects the notions of preferred and optimal phenotype because these have an 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 have a 1-yr life cycle, are an important forage fish, and serve as a sentry of habitat and fish community health in the Hudson River Estuary (New York / New Jersey, USA). Two concurrent projects on tomcod are underway that address ecological and toxicological themes. Regarding the ecological theme, estimates are being obtained for: 1) maternal effects on offspring quality; 2) ontogenetic rates of eggs, larvae, and juveniles; 3) time of settlement, behavioral transitions with respect to habitat structure, and movement of juveniles in nature; and 4) risk of predation. Regarding the toxicological theme, three source populations – Hudson River, Shinnecock Bay (Long Island, New York) and Miramichi River (New Brunswick, Canada) that differ in contaminant histories are being compared with respect to: 1) uptake and depuration rates of dioxin and locally occurring (Hudson River) congeners of PCBs; 2) sublethal toxic responses to graded doses of local PCBs congeners using captive (F1 and F2) tomcod populations; and 3) interactions between environmental stressors, i.e., PCBs and high summer temperatures. The toxicological work in 2006-07 includes an assessment of the combined effects of PAHs and PCBs on ecologically relevant toxic endpoints. Collaborations in 2006-07 with colleagues at New York University and at University of Maryland Eastern Shore include evaluating the incidence of tumors in laboratory-reared F1 juveniles exposed as embryos and larvae / juveniles to combinations of PAHs and PCBs. A pilot assessment of the effects of nanoparticles on tomcod early life-stages has also been initiated.

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 studied for evidence of selective mortality during their first season of growth.

Hudson River Estuary Ecosystem: Field and laboratory evaluations are ongoing of patterns of abundance of the ichthyofauna of the Hudson River Estuary Ecosystem and of the processes that affect abundances. 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 ongoing surveys by state and private concerns, are being analyzed for community wide patterns, and for associations between target species and habitat variables.

Pelagic Fishes: Movements of three pelagic fish species (bluefish, weakfish and striped bass) were monitored using an acoustic hydrophone array and acoustic tags in a small Northeastern estuarine system to determine how these species use multiple habitats to meet life history requirements. Attempts are being made to define patterns at finer scales than previously determined using traditional fishery methods of collection (nets and hook and line) and to nest this information within a matrix of habitat dynamics and fish ecophysiology. During 2006, broad-scale patterns of habitat use were compared to hydrographic information obtained concurrently from a smaller array of instruments measuring a variety of environmental variables (temperature, salinity, dissolved oxygen, current speed and direction and tidal height and turbidity). In 2006, 78 fish (34 striped bass, 29 bluefish, and 15 weakfish) were acoustically tagged and released. Habitat utilization patterns indicated the use of marsh creeks, upstream tributaries, and an estuarine turbidity front; however, movements were complicated by tidal and diurnal influences.

Juvenile Lobster Study: The Milford Laboratory has completed a 3-year study of habitat use by juvenile lobsters on a natural reef located in Long Island Sound. Small lobsters were sampled using nylon mesh fish traps on a cobble reef, off Charles Island near Milford, Connecticut. Thirty to 60 traps were placed at 10 different sites on and adjacent to the reef. Most of the lobsters collected ranged in size from 30 to 60 mm

carapace length (CL). Lobster capture was greatest from mid-June through early July. Kruskal-Wallis ANOVA was used to assess differences in lobster abundance (catch per unit effort or CPUE) within each year and for all three years combined. Lobster CPUE was consistently higher at sites containing cobble substrate versus adjacent areas, having sandy or muddy bottom sediments. Delta means, which adjust for the presence of zero catches in the data set, were estimated and showed similar patterns in CPUE for the three study years. Geospatial kriging was used to map lobster distribution patterns in the vicinity of the reef. Lobsters greater than 30 mm CL were marked using stainless steel Sphyrion anchor style tags (Floy) made of polyolefin tubing. The mark-recapture study found that lobsters were generally recaptured at their initial tagging site, suggesting that lobsters demonstrate limited geographic movement on the reef during the summer season. Recapture rate for lobsters over the study period was 7.1%. Recaptured lobsters remained at liberty from 1 to 376 days. Jolly-Seber mark-recapture analysis was used to estimate population size of young lobsters in the area of the reef. Results suggest that this cobble reef is an important habitat for young lobsters within Long Island Sound.

b) Resource Surveys Cruises

During 2006, personnel from the Ecosystems Surveys Branch (ESB) staged, staffed and supported the winter, spring and fall multispecies bottom trawl surveys, and the northern shrimp, sea scallop, hydroacoustic, gear experiment, non-ESB and cooperative surveys for a total of 298 research and charter vessel sea days. NOAA scientific staff provided a total of 1,856 staff sea days and volunteers contributed another 568 person sea days. ESB cruises occupied 1490 stations in an area extending from Cape Hatteras, North Carolina to Nova Scotia, including the Gulf of Maine. A total of 2,242,161 length measurements were taken from 311 species during these cruises. Ecosystem survey data currently are utilized as fishery independent abundance or biomass inputs in 48 single species stock assessments and also in several ecosystem dynamics modeling efforts.

Significant effort was also expended to fulfill requests from 50 NOAA and University investigators for samples or observations made during the various survey cruises. These included 16,600 feeding ecology observations, 27,268 aging structures, and 19,796 samples or individual specimens to support additional shore based research.

Scientists, regional gear manufacturers, academic scientists and commercial fishery stakeholders collaborated to design and test a new survey bottom trawling system that will be used aboard the new research vessel, the FSV Henry B. Bigelow. A similar collaborative effort is currently being undertaken to redesign survey scallop dredges. The FSV Henry B. Bigelow was delivered to NOAA Fisheries during August 2006 and is expected to commence scientific data collection operations out of Newport, Rhode Island in September 2007. Initial survey efforts will focus on calibration of bottom trawl catchability with existing bottom trawl survey operations conducted on the RV Albatross IV.

c) Age and Growth

Approximately 33,000 age determinations for nine species of finfish were completed in 2006 by Woods Hole Laboratory staff in support of resource assessment analyses. In addition to Atlantic cod (7,824), haddock (5,671), and yellowtail flounder (6,204), 6,862 summer flounder and 2,459 scup were aged. Age determinations for Atlantic herring, pollock, goosfish, and white hake totaled 3,804.

Cod and haddock age structures were exchanged with age readers from Canada's Department of Fisheries & Oceans St. Andrews Biological Station in a continuing effort to maintain comparability of age determinations between laboratories. Summer flounder age structures were exchanged with North Carolina's Department of Marine Fisheries to support research recommendations of the Atlantic States Marine Fisheries Commission. The Woods Hole Laboratory participated in an Atlantic herring Aging Workshop convened by Maine's Department of Marine Resources in January 2006 to standardize ageing methodologies among agencies and to discuss generic herring ageing research issues.

Research projects initiated in 2006 included: 1) a broad study to enumerate current fecundity levels of

various 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 examination of recent trends in mean weights at age for several flatfish species.

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 2006 winter survey, 3,828 stomachs from 44 species were examined, while 5,703 stomachs from 54 species, and 7,069 stomachs from 55 species were examined during the spring and autumn 2006 surveys, respectively. Diet sampling emphasized small pelagics, elasmobranchs, gadids, flatfishes, and lesser known species.

The 34 year time series (1973-2006) 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 2006 bottom trawl survey food habits data is scheduled for completion in 2007.

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 2006. Information was received on about 5,000 tagged and 400 recaptured fish bringing the total numbers tagged to 198,000 sharks of more than 50 species and 12,000 sharks recaptured of 33 species.

A collaborative program to examine the biology and population dynamics of the blue shark and shortfin mako in the North Atlantic continued in 2006, with estimates of survival rates calculated from mark-recapture data. This study is critical for use in stock assessment and is being conducted in collaboration with scientists at the School of Aquatic and Fishery Sciences, University of Washington and the Graduate School of Oceanography, University of Rhode Island.

An age and growth study of the smooth skate (*Malacoraja senta*) was completed in conjunction with the University of New England. These results were presented at the 2006 American Elasmobranch Society meeting and a manuscript submitted for publication in the symposium volume. A new approach to estimate the trophic position of sharks in marine food webs was published in Ecology. Stable ^{15}N and ^{13}C analysis conducted on white shark vertebrae demonstrated that incremental analysis of isotopes along the radius of a vertebral centrum produces a chronological record of dietary information allowing for reconstruction of an individual's trophic history. Isotopic values verified two distinct ontogenetic trophic shifts in the white shark: one following parturition and one at a total length of >341 cm when diet shifts from fish to marine mammals. A life history study of the torpedo ray was initiated with researchers from the University of Rhode Island.

In 2006, landings information and biological samples for age and growth, feeding ecology, and reproductive studies and catch data for pelagic sharks were collected at recreational fishing tournaments in the Northeastern United States. The collection and analysis of these data are critical for input into species and age specific population and demographic models for shark management.

Staff participated in the Southeast Data, Assessment, and Review (SEDAR) Workshop for the assessment of the U.S. large coastal shark complex. Working papers were prepared summarizing sandbar and blacktip mark/recapture data, NEFSC historical longline surveys and biological sampling, relative abundance trends for juvenile sandbar sharks in Delaware Bay, and catch rate information from the NMFS Northeast longline surveys.

Reproductive dynamics and nursery ground studies also continued with a random stratified sampling plan based on depth and geographic location to develop a time series to estimate and monitor the relative abundance and population size of sandbar sharks in Delaware Bay throughout the nursery season and from year to year. The time series data were used in the SEDAR Workshop to assess sandbar shark stocks. Catch per unit effort (CPUE) in number of sharks per 50-hook set per hour was used to examine the relative abundance of juvenile sandbar sharks in Delaware Bay during the summer nursery seasons from 2001 to 2005. CPUE was standardized using an offset of the natural logarithm of the CPUE in a generalized linear model, which took into account the effects of year, month, region, and depth strata. CPUE was also standardized using a modified two-step approach based on a delta-lognormal model which models the zero catch separately from the positive catch. Results from both standardization methods and the nominal CPUE values indicated that the relative abundance of juvenile age 1+ and young of the year sandbar sharks has remained fairly constant with only a significant drop in juvenile age 1+ abundance in 2002, which may be attributed to a large storm that passed through the Bay that year.

f) Marine Mammals

Small Cetaceans: During 6-26 July 2006, the NOAA *R/V Delaware II* was used to biopsy and photograph pilot whales (*Globicephala* spp.) from the southern portion of Georges Bank to Cape Hatteras, North Carolina concentrating off the US continental shelf. Collected genetic tissues will be used to determine the distribution and geographic overlap of long-finned (*G. melas*) and short-finned pilot whales (*G. macrorhynchus*) during the summer survey period. A secondary objective was to collect biopsy samples of other cetaceans for which additional stock identification data are useful [e.g. sperm whales (*Physeter macrocephalus*) and striped dolphins (*Stenella* spp.)].

Incidental bycatches of cetacean, turtle, and seal species were estimated from those that were observed taken in commercial fisheries from Maine to North Carolina. Fisheries observed during 2006 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*), bottlenose dolphins (*Tursiops truncatus*), common dolphins (*Delphinus delphis*), white-sided dolphins (*Lagenorhynchus acutus*), and pilot whales. In addition, incidental fishery takes of harbor seals (*Phoca vitulina*), gray seals (*Halichoerus grypus*), harp seals (*Pagophilus groenlandicus*), loggerhead turtles (*Caretta caretta*), Kemp's ridley turtles (*Lepidochelys kempii*), and leatherback turtles (*Dermochelys coriacea*) were observed.

Large Cetaceans: During 31 July - 4 August 2006, NEFSC conducted passive acoustic research in slope/shelf waters around Georges Bank and in the western portion of Browns Bank. The primary objectives of the cruise were to set up a hydrophone array and associated software for the detection of sperm whales, right whales (*Eubalaena glacialis*) and harbor porpoises, and to train NEFSC personnel in the operation of the equipment. Secondary objectives were to conduct visual surveys for marine mammals and to test and calibrate hand-held computers and software for future cetacean line-transect surveys.

During 12-16 August 2006, a marine mammal habitat survey was conducted in the western Gulf of Maine. The primary objectives were to collect information on the relationship between cetaceans and potential prey using an IGYPT mid-water trawl; to collect information on oceanographic features using CTD data; and to conduct visual surveys for marine mammals. Secondary objectives were to collect photo

identification data on pilot whales and obtain biopsy samples from bow riding pilot whales, white-sided dolphins and white-beaked dolphins (*L. albirostris*).

Using *R/V Albatross IV*, the NEFSC, in conjunction with the Woods Hole Oceanographic Institution, conducted a habitat sampling and tagging study to better understand right whale foraging behavior in the Great South Channel area off Massachusetts, USA. Conducted during four weeks in May 2006, this was the third such survey; a fourth survey will be performed during May 2007.

During all months of 2006, the NEFSC conducted aerial sighting surveys for right whales in the Great South Channel, Gulf of Maine, and Georges Bank areas. These surveys included directed surveys, as well as broad-scale tracks designed to assess both presence and absence of right whales (and other cetaceans) over the entire Gulf of Maine region.

An aerial abundance survey of cetaceans and turtles was conducted on the NOAA DeHavilland Twin Otter aircraft from 24 July to 26 August 2006. The study area extended from New Jersey, USA (74° 20'N 39° 40'W), eastward to the Gulf of St. Lawrence (58° 30'W), and northward to the Bay of Fundy (45° 30'N). The objective of this survey was to describe the habitat of and estimate the abundance of cetaceans and turtles in the study area. Track lines were flown at 600 feet (183m) above the water surface, at about 110 knots. A total of 6,594.3 nautical miles of track line were flown. Sightings included 4,278 cetaceans (20 right whales), 57 turtles and 203 seals.

A large scale passive acoustic study was undertaken for 14 months starting in January 2006 throughout the Stellwagen Bank National Marine Sanctuary in collaboration with the Sanctuaries Office and Cornell University. Ten passive acoustic recording units were deployed and retrieved every three months cataloguing all biological and anthropogenic sounds between 5 and 1000Hz. Analyses of the acoustic distribution and occurrence of northern right, humpback and fin whales (*Balaenoptera physalus*) and fish species are currently being analyzed and related to other existing data bases. Anthropogenic noise and vessel movements are being mapped in relation to biological activity and occurrence. More details can be found at: http://stellwagen.noaa.gov/science/passive_acoustics.html

Scarification analyses of right and humpback whales continued in 2006. These analyses are used to monitor interactions between whales and fishing gear.

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

Pinnipeds: In 2006, seal scat collection took place in Maine at the Isles of Shoals, and in Massachusetts at Jeremy Point (Wellfleet), Muskeget Shoals (off Nantucket) and S. Monomoy National Wildlife Refuge (Chatham). The purpose of the research was to learn more about the diet and diseases of harbor and gray seals.

Another research project focused on gray seal recolonization in the northeast U.S. The project has several components including aerial surveys of the breeding sites to better assess the current population size and distribution.

Haul-out behaviors and interactions of harbor and gray seals were observed to identify competitive interactions and displacement. Most of this research was land-based observation from a distance of approximately 750 m. One small boat survey was conducted in 2006 in conjunction with the scat collection research described above.

g) Turtles

The NEFSC collaborated with academics, industry groups, and staff from other NMFS science centers to assess and reduce sea turtle bycatch in domestic commercial fisheries in the Northwest Atlantic Ocean. In 2006, research efforts were focused on the Mid-Atlantic bottom trawl fisheries and the Mid-Atlantic sea scallop (dredge and trawl) fisheries.

In the Atlantic sea scallop fishery, NEFSC undertook both bycatch analysis 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 in the Mid-Atlantic region. A gear research team examined a modified scallop dredge frame in an experimental setting and later completed preliminarily field trials to examine changes in target catch when the modified dredge was used in the fishery. Video projects recorded information about how the dredge fishes, but were not able to capture any turtle/gear interactions. The NEFSC is continuing to work with scallop fishing industry participants to better observe, analyze, and mitigate turtle-dredge interactions.

NEFSC also undertook both bycatch analysis and gear research in the Mid-Atlantic bottom trawl fisheries. Observed turtle interactions with commercial vessels in the U.S. bottom otter trawl fisheries were used to estimate bycatch of loggerhead sea turtles in the Mid-Atlantic region from 1996-2004. Significant factors affecting sea turtle bycatch were latitude zone, depth, sea surface temperature, and the use of a working Turtle Excluder Device (TED). NEFSC also collaborated with staff from other NMFS science centers, the Mid-Atlantic trawl fishing industry, and URI on several gear research initiatives. To initiate the process for reducing sea turtle bycatch in the southern New England and Mid-Atlantic inshore bottom trawl fisheries, NEFSC contracted URI to host a workshop with NMFS and the fishing industry to discuss bycatch reduction technologies. In addition, pilot testing of TEDs on commercial vessels was conducted in the Mid-Atlantic region.

h) Seabirds

The NEFSC initiated bycatch analysis in 2006 on seabird incidental takes in the gillnet fisheries based on observer data.

3. Studies of Fishing Operations

In 2006, NEFSC observers were deployed on 2,478 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 122 marine mammal incidental takes, 12 sea turtle incidental takes, and 50 seabird incidental takes. For most of these animals, take information was recorded which included 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 was collected when possible.

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

In the sink anchored gillnet fishery, 792 trips were observed with a total of 3,441 gear retrievals. There were 83 observed marine mammal takes in this fishery (52 harbor porpoises, 9 gray seals, 7 unidentified seals, 4 harbor seals, 4 harp seals, 3 common dolphins, 2 atlantic white-sided dolphins, and 2 unidentified porpoise/dolphins). There were also 2 sea turtle takes (1 Kemp's ridley and 1 leatherback) and 34 seabird takes observed in the fishery.

b) Float Drift Gillnet Fishery

In the float drift gillnet fishery, 30 trips were observed with a total of 136 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, 948 were observed with a total of 13,402 gear retrievals. In addition, there were 25 midwater trawl trips with 90 gear retrievals, 34 scallop trawl trips with 165 gear retrievals and 21 shrimp bottom otter trawl trips with 75 gear retrievals. In the bottom otter trawl fishery, there were 32 observed marine mammal takes (15 common dolphins, 6 atlantic white-sided dolphins, 3 pilot whales, 3

harbor porpoises, 2 unidentified whales, 1 unidentified toothed whale, 1 unidentified dolphin, and 1 unidentified porpoise/dolphin). There were also 7 loggerhead turtle takes and 10 seabird takes in this fishery. In the mid-water trawl fishery there were 2 seabird takes. In the scallop trawl fishery there were 2 loggerhead turtle takes. No marine mammal, sea turtle, or seabird takes were observed in the shrimp trawl fishery.

d) Sea Scallop Dredge Fishery

In the sea scallop dredge fishery, 237 trips were observed with a total of 16,283 gear retrievals. There was one loggerhead turtle take observed in this fishery.

e) Conch Pot Fishery

No conch pot trips were observed in 2006.

f) Scottish Seine Fishery

No Scottish seine trips were observed in 2006.

g) Sink Drift Gillnet Fishery

In the sink drift gillnet fishery, 225 trips were observed with a total of 1,256 gear retrievals. There were 3 observed marine mammal takes in this fishery (two bottlenose dolphins and one unidentified seal), as well as one seabird take.

h) Anchored Floating Gillnet Fishery

In the anchored floating gillnet fishery, 11 trips were observed with a total of 29 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, 31 trips were observed with a total of 90 gear retrievals. There were 3 atlantic white-sided dolphin takes and 2 seabird takes observed in this fishery.

j) Bottom Longline Fishery

In the bottom long line fishery, 100 trips were observed with a total of 608 gear retrievals. There were 3 seabird takes observed in this fishery.

k) Beach Haul Seine Fishery

In the beach haul gillnet fishery, 8 trips were observed with a total of 9 gear retrievals. No marine mammal, sea turtle, or seabird takes were observed in this fishery.

l) Pound Net Fishery

No pound net trips were observed in 2006.

m) Handline Fishery

There was one handline trip observed with two gear retrievals. No marine mammal, sea turtle, or seabird takes were observed in this fishery.

n) Herring Purse Seine Fishery

No herring purse seine trips were observed in 2006.

o) Lobster Pot Fishery

There was one lobster pot trip observed with 16 gear retrievals. No marine mammal, sea turtle, or seabird takes were observed in this fishery.

o) Fish Pot Fishery

No fish pot trips were observed in 2006.

p) Clam Dredge Fishery

In the clam dredge fishery, 14 trips were observed with a total of 532 gear retrievals. No marine mammal, sea turtle, or seabird takes were observed in this fishery.

4. Population Dynamics Research

Population dynamics research conducted within the NEFSC supports a number of domestic and international fisheries management authorities. Within the United States Northeast Region, management plans are developed by the New England (states of Maine through Connecticut) and Mid-Atlantic (New York through North Carolina) Fishery Management Councils, and the Atlantic States Marine Fisheries Commission (ASMFC). There are about three dozen managed species; many require annual stock status updates as a basis for fishery management. Stock assessments are routinely reviewed in a peer review process termed the Northeast Regional Stock Assessment Workshop (SAW). Two such workshops are conducted annually, with the focus of the workshops being the review of Abenchmark@ assessments (*e.g.*, those using new analytical approaches, or for species that have never been assessed quantitatively or for which peer reviewed assessments have not been conducted for several years). The SAW reviews about 4-10 stock assessments each year. However, not all assessments conducted by the NEFSC are vetted at the SAW. Some are reviewed in international fora (*e.g.*, US/Canada Transboundary Resources Assessment Committee [TRAC]; ICES; etc), while others are vetted in regional bodies (*e.g.*, ASMFC science boards; Management Council Plan Development Teams, etc). Apart from stock assessment research for management purposes, population dynamics research in 2006 focused on a number of other management and scientific issues. Four such areas are highlighted:

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/NASCO stock assessment activities.

Field research in 2006 focused on obtaining smolt production estimates, telemetry studies of emigrating hatchery and wild smolts, 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. 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 study fleet research program in the northeastern USA in which commercial fishing vessels provide more accurate, more detailed (temporal and spatial), and more comprehensive data than would be obtained without deploying fishery observers. The 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. The ELB system comprises: (a) a software application in which fishermen enter trip, effort, and catch information; (b) a gear-mounted temperature-depth probe; and (c) a GPS unit used to track the precise time and location of fishing effort. Study fleet fishermen receive training on the use of the ELB system and on proper catch reporting protocols. NEFSC scientists conduct regular 'refresher' trips with participating vessels.

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 exported to the NEFSC using a vessel's electronic Vessel Monitoring System (VMS); raw trip data are available for analysis less than an hour after the end of the trip. In the background, the ELB software polls the vessel's GPS unit at high-frequency intervals (> 1 fix/30 seconds). Vessels are also equipped with gear-mounted, temperature-depth (TD) probes, which collect high-frequency (> 1 observation/2 minutes) data on gear depth and water temperature. The GPS and TD data are collected from the vessels by field staff approximately once per month. Post-processing of these data provide high-resolution information on the location, timing and duration of fishing effort, and the resulting catches.

To date, over 1,200 trips have been taken by 32 different vessels in the Study Fleet Pilot Program. A phased approach has been used to develop the technology and standard protocols to support the data acquisition and recording elements of the Program. Phase I involved 15 participants and focused on developing the ELB software and testing the necessary hardware. Beginning in September 2004, Phase II expanded the pilot fleet to 32 vessels and focused on the continued testing and refinement of the ELB technology. Particular emphasis was placed on developing satellite communications and perfecting the ELB software. Analyses of catch data collected in Phases I and II 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 initiated in September 2005 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 discuss viable catch sampling and sub-sampling procedures with captains and crew. Additionally, technicians 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 assess the efficacy of any standard protocols which will be implemented. Additionally, limited deployments late in 2007 will concentrate on small (< 20 vessels) data-poor fisheries which lack sufficient observer coverage in an attempt to improve estimates of fishing effort used in stock assessments, while groundfish fleet deployment options are evaluated.

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 classical methods such as ADAPT -VPA, reference point estimation, surplus production and forward-projection methods into a stable environment with tested software products. The NFT will be used for most 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 14 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. No additional programming is required by the user to test performance of several models to recover the true underlying parameters. The complete package may be accessed at <http://nft.nefsc.noaa.gov> (username: nft, password: nifty).

In 2006 the NFT added Stock Synthesis-2 to the available models. In addition, ASPIC was updated to improve the user interface. In 2007 there will be a major revision to many of the models to improve features for data input and plotting. The new version of VPA will provide the capability of running bootstrapping combined with retrospective analyses. Stock Synthesis-2 will be updated and the toolbox web site itself will be substantially modified. Additionally, a Visual Report Designer tool will be introduced in 2007 to present trends in model results in a symbolic interface format.

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, predator/prey studies, and dynamic length-based stock assessment models.

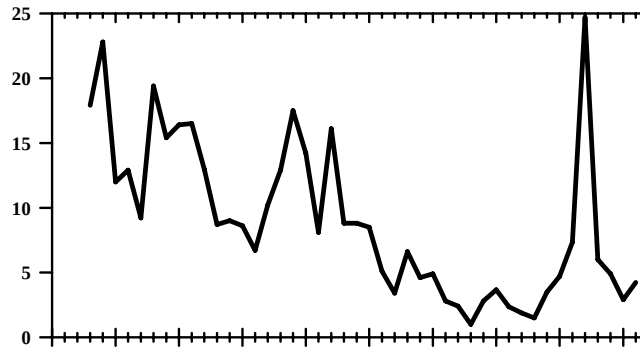


Figure 1. NEFSC autumn bottom trawl survey biomass indices for Gulf of Maine cod.

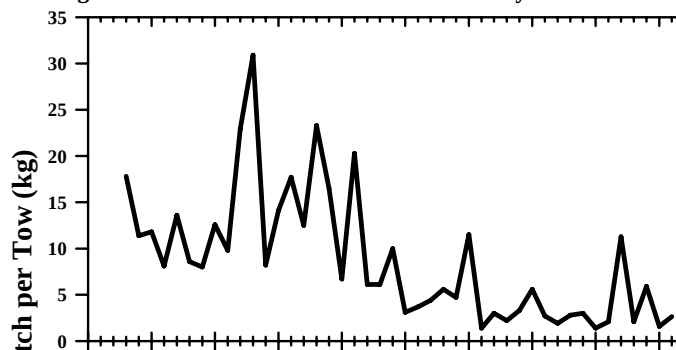


Figure 2. NEFSC autumn bottom trawl survey biomass indices for Georges Bank cod.

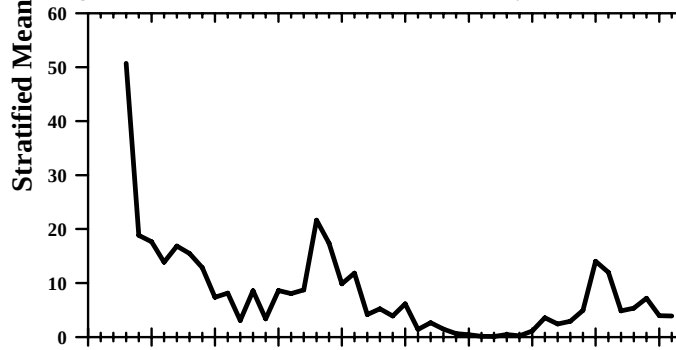


Figure 3. NEFSC autumn bottom trawl survey biomass indices for Gulf of Maine haddock.

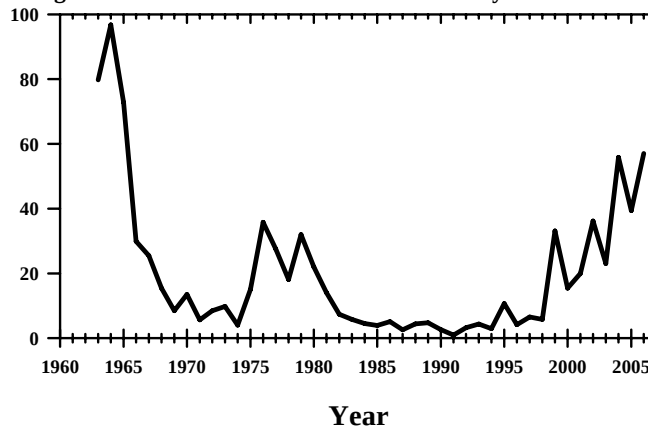


Figure 4. NEFSC autumn bottom trawl survey biomass indices for Georges Bank haddock.

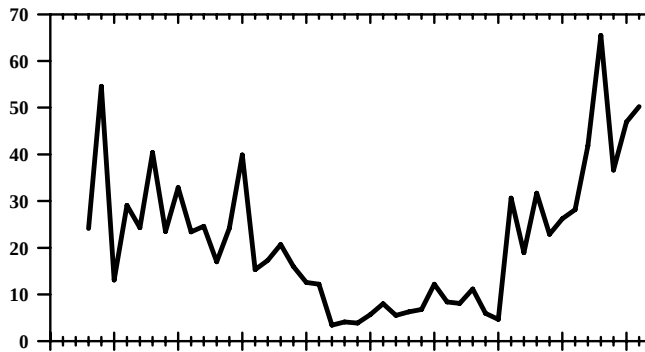


Figure 5. NEFSC autumn bottom trawl survey biomass indices for redfish.

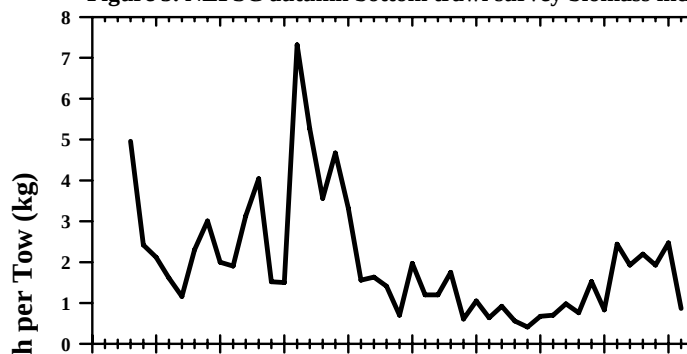


Figure 6. NEFSC autumn bottom trawl survey biomass indices for pollock.

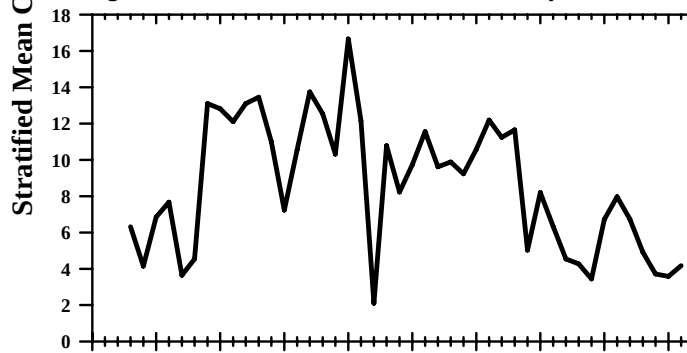


Figure 7. NEFSC autumn bottom trawl survey biomass indices for white hake.

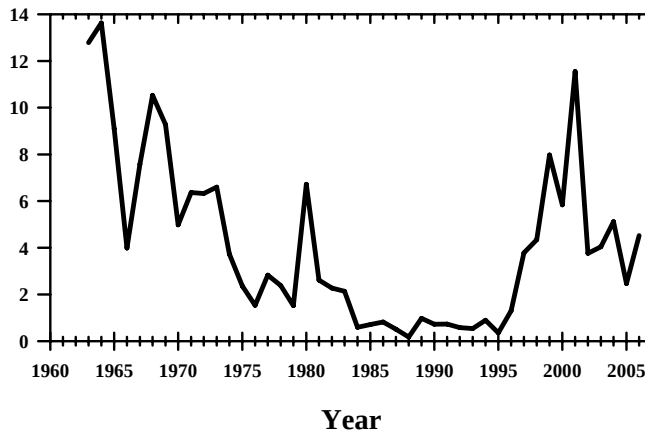


Figure 8. NEFSC autumn bottom trawl survey biomass indices for Georges Bank yellowtail flounder.

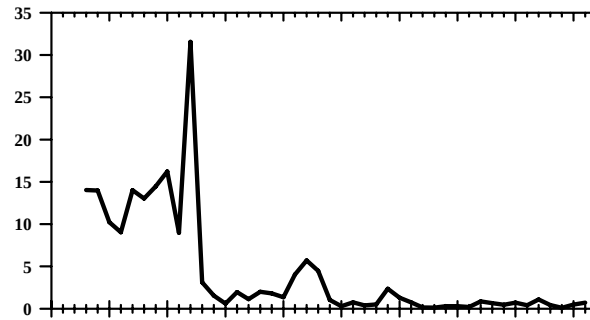


Figure 9. NEFSC autumn bottom trawl survey biomass indices for Southern New England-Mid-Atlantic yellowtail flounder.

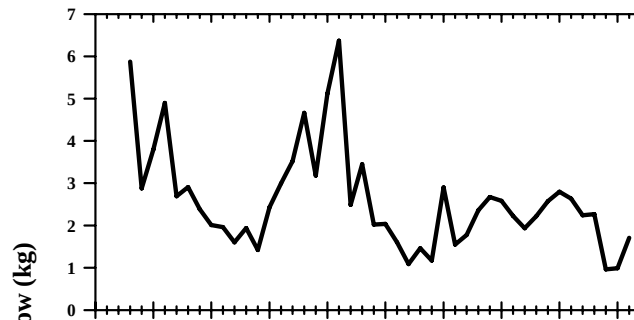


Figure 10. NEFSC autumn bottom trawl survey biomass indices for American plaice.

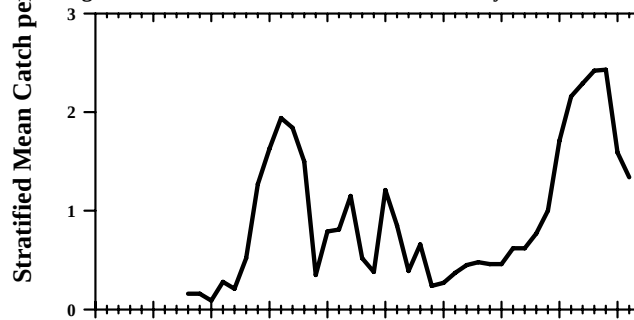


Figure 11. NEFSC spring bottom trawl survey biomass indices for summer flounder.

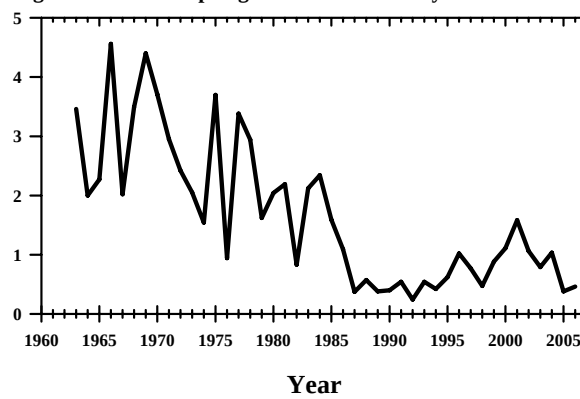


Figure 12. NEFSC autumn bottom trawl survey biomass indices for witch flounder.

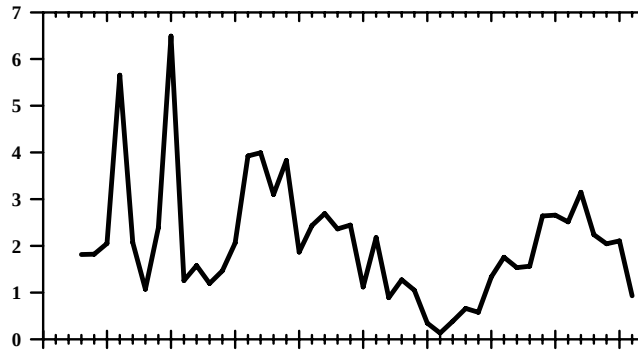


Figure 13. NEFSC autumn bottom trawl survey biomass indices for Georges Bank winter flounder.

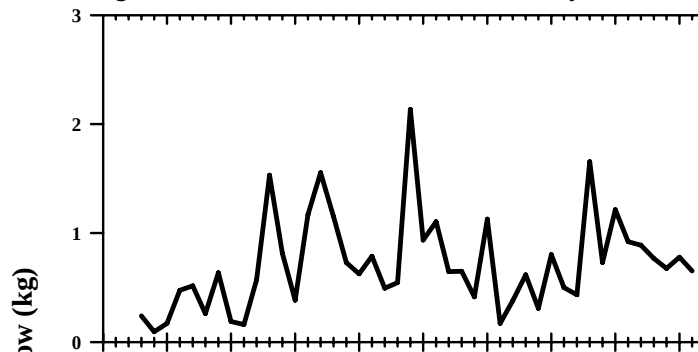


Figure 14. NEFSC autumn bottom trawl survey biomass indices for northern windowpane flounder.

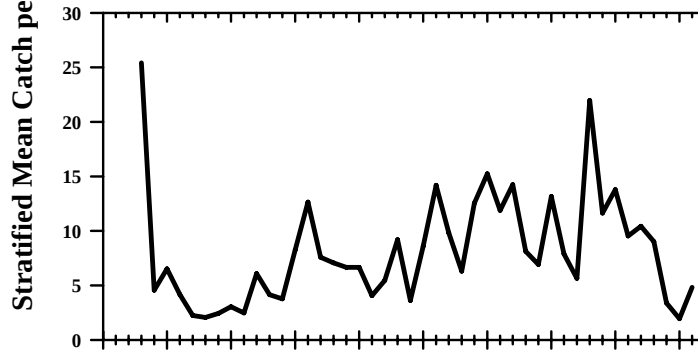


Figure 15. NEFSC autumn bottom trawl survey biomass indices for northern silver hake.

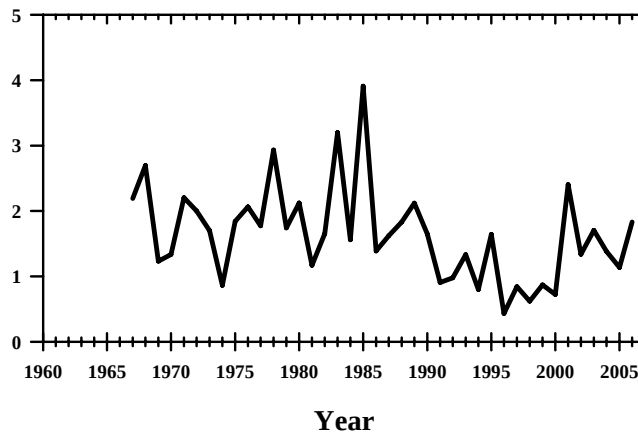


Figure 16. NEFSC autumn bottom trawl survey biomass indices for southern silver hake.

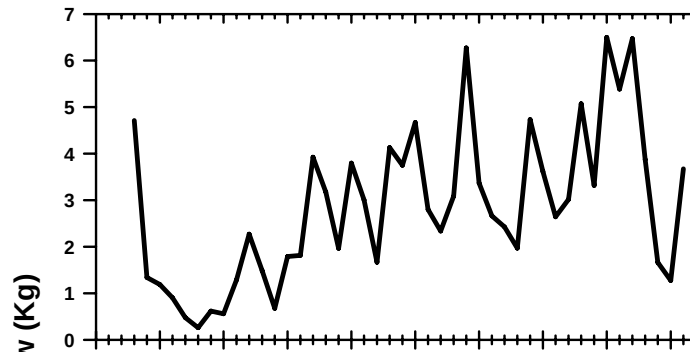


Figure 17. NEFSC autumn bottom trawl survey biomass indices for northern red hake.

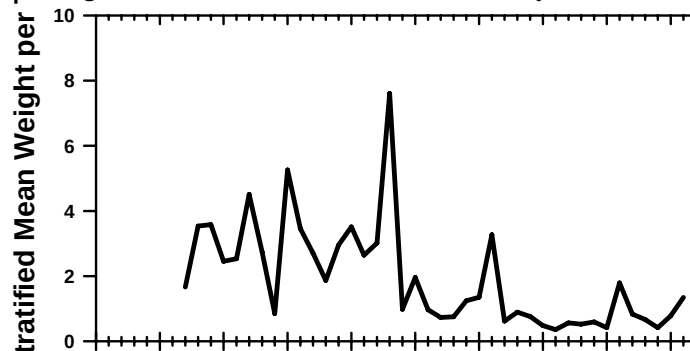


Figure 18. NEFSC autumn bottom trawl survey biomass indices for southern red hake.

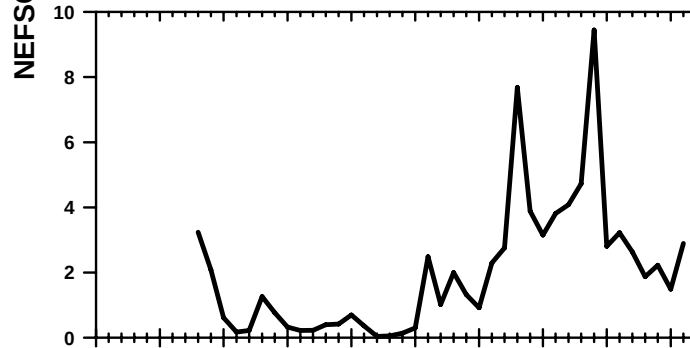


Figure 19. NEFSC spring bottom trawl survey biomass indices for Atlantic herring.

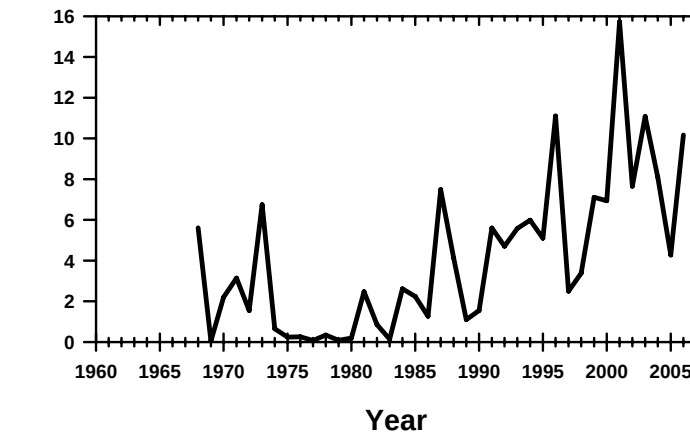


Figure 20. NEFSC spring bottom trawl survey biomass indices for Atlantic mackerel.

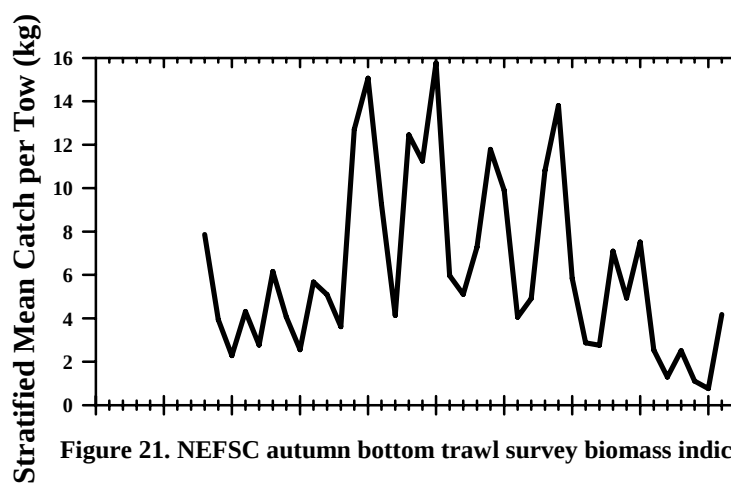


Figure 21. NEFSC autumn bottom trawl survey biomass indices for butterfish.

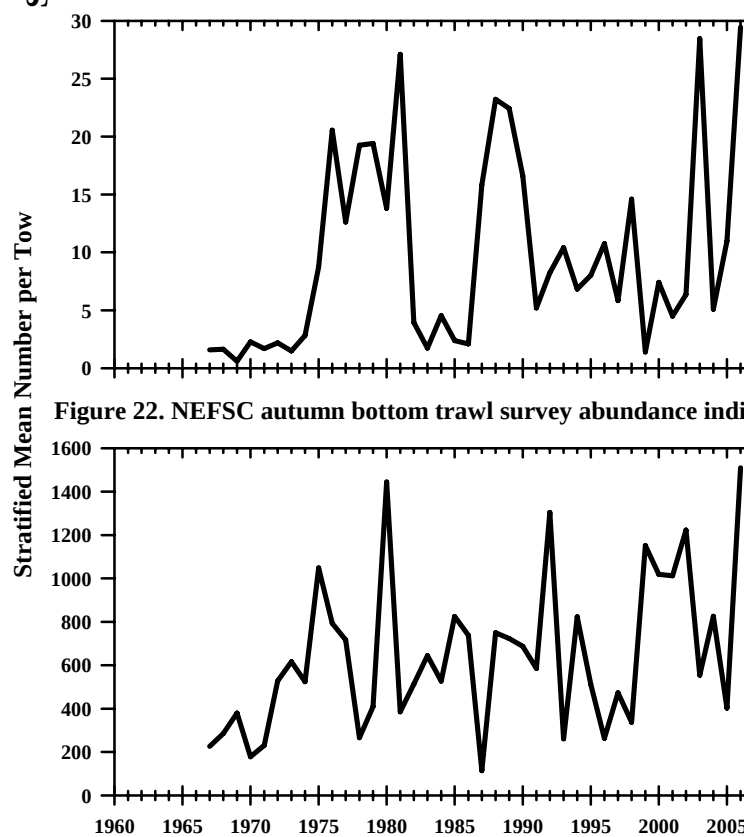


Figure 22. NEFSC autumn bottom trawl survey abundance indices for *Illex*.

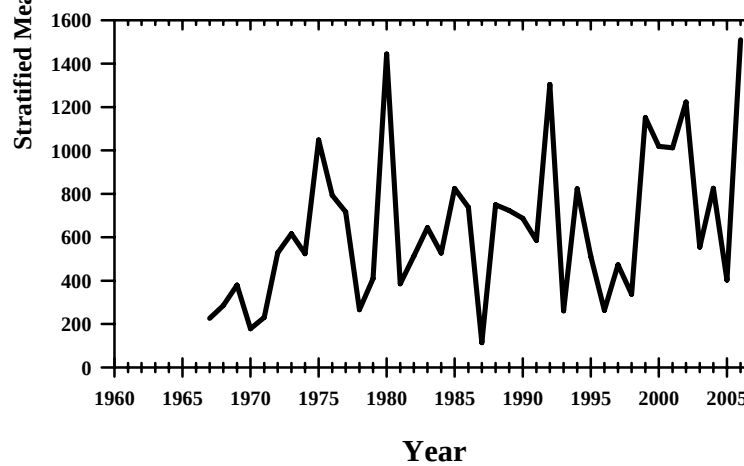


Figure 23. NEFSC autumn bottom trawl survey abundance indices for *Loligo*.

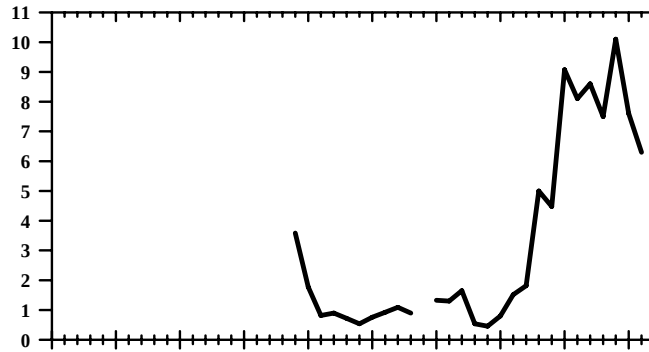


Figure 24. NEFSC scallop survey biomass indices for Georges Bank sea scallops.

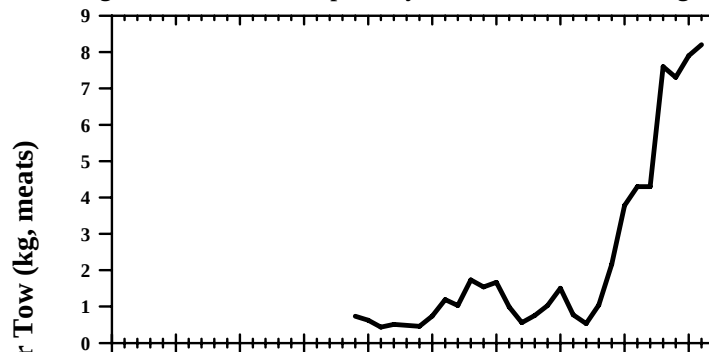


Figure 25. NEFSC scallop survey biomass indices for Mid-Atlantic Bight sea scallops.

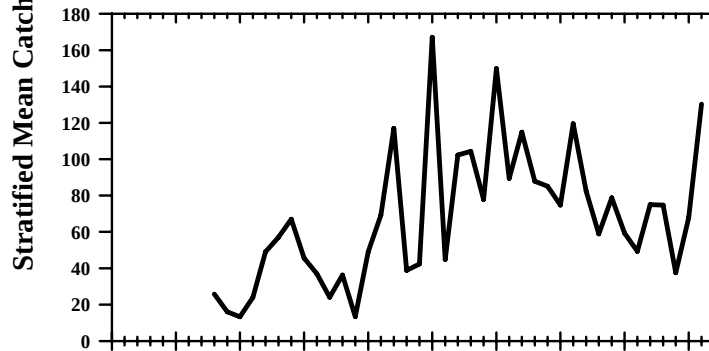


Figure 26. NEFSC spring survey biomass indices for spiny dogfish.

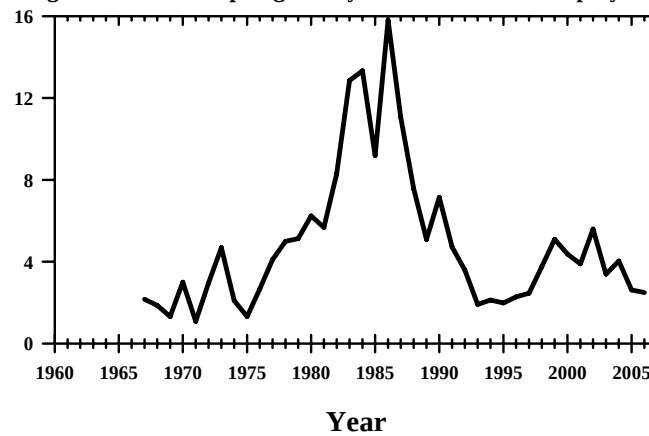


Figure 27. NEFSC autumn survey biomass indices for winter skate.

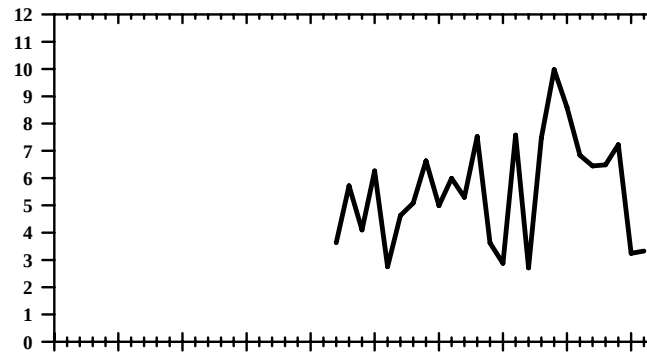


Figure 28. NEFSC spring survey biomass indices for little skate.

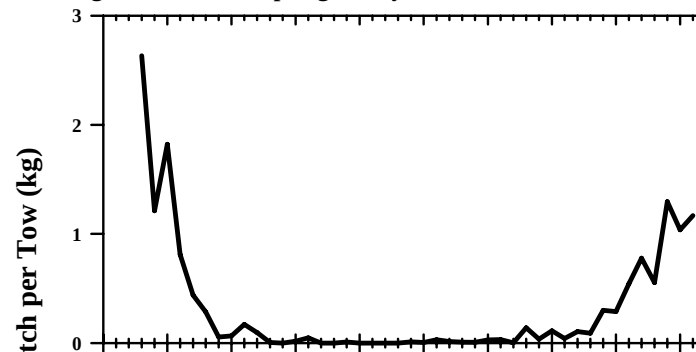


Figure 29. NEFSC autumn survey biomass indices for barndoor skate.

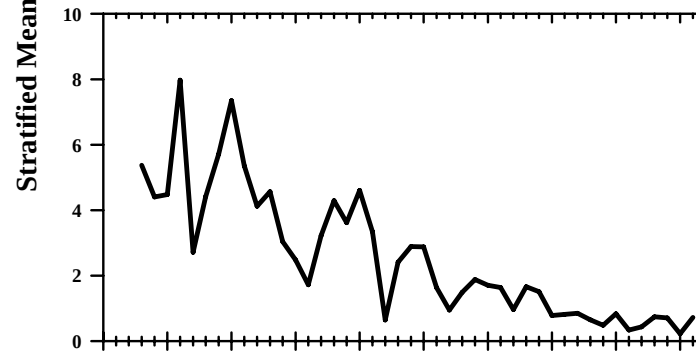


Figure 30. NEFSC autumn survey biomass indices for thorny skate.

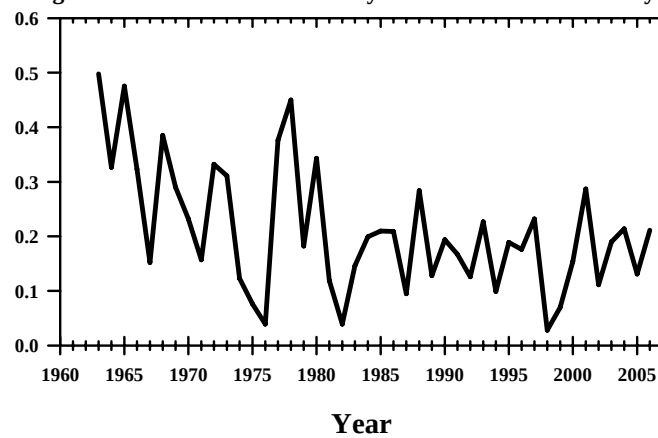


Figure 31. NEFSC autumn survey biomass indices for smooth skate.

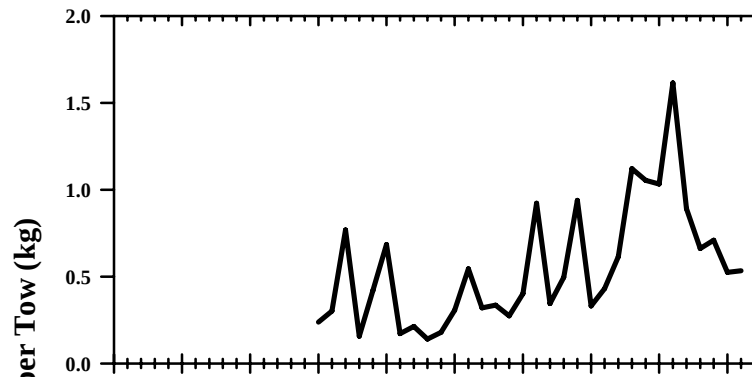


Figure 32. NEFSC autumn survey biomass indices for clearnose skate.

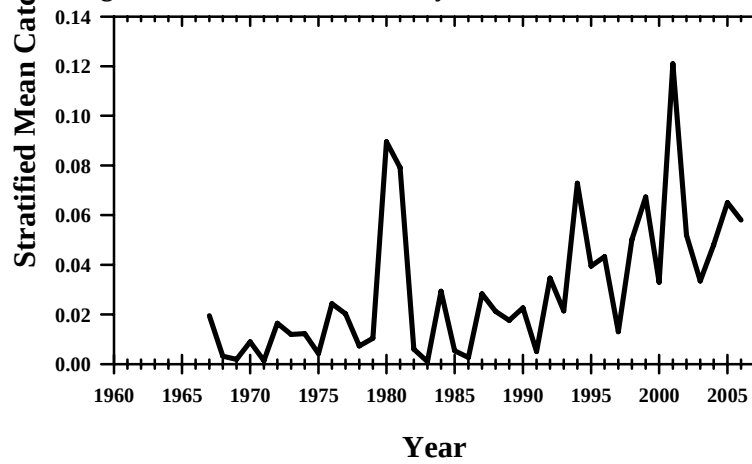


Figure 33. NEFSC autumn survey biomass indices for rosette skate.