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United States Research Report for 2004

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.

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 4-6 in 2004 were 7,287 mt, a 32% decrease from 2003 landings of 10,692 mt and a 44% decrease from the 13,096 mt landed in 2002.

USA cod landings from the Gulf of Maine (Div. 5Y) in 2004 were 3,798 mt, a 6% decrease from 4,028 mt landed in 2003. 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 in 2004 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. The autumn survey index declined in 2003 and 2004 and is now at about the same level as in 2000 (Figure 1).

USA cod landings from Georges Bank (Div. 5Z and SA 6) in 2004 were 3,470 mt, a 48% decrease from 6,645 mt landed in 2003 and a 61% decrease from 9,000 mt landed in 2002. The NEFSC research vessel survey biomass indices remained near record-low levels during 1991-2003, with the exception of the sharp increase in the 2002 index due primarily to a large catch at one station (Figure 2). The survey biomass index increased slightly in 2004 as a result of three large tows in three separate strata.

**2. Haddock**

USA haddock (*Melanogrammus aeglefinus*) landings increased 22% from 6,741 mt in 2003 to 8,200 mt in 2004. Georges Bank (Div. 5Z) haddock landings increased 35% from 5,309 mt in 2003 to 7,180 mt in 2004. Gulf of Maine (Div. 5Y) haddock landings declined by 29% between 2003 and 2004 from 1,432 mt to 1020 mt. Landings of both stocks are below historical yields.

Research vessel survey biomass indices increased in 2004 for both the Gulf of Maine and Georges Bank stocks (Figures 3 and 4). Spawning stock biomass of Georges Bank haddock increased in 2004 and is

expected to increase further due to relatively low fishing mortality rates and recruitment of the strong 2003 year-class.

### 3. **Redfish**

USA landings of Acadian redfish (*Sebastes fasciatus*) decreased by 4% from 416 mt in 2003 to 398 mt in 2004. Research vessel survey biomass indices have generally increased since 1996 (Figure 5) and are now at levels comparable to 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.

### 4. **Pollock (4VWX + 5 stock)**

USA landings of pollock (*Pollachius virens*) increased by 8% from 4,680 mt in 2003 to 5061 mt in 2004. Research vessel survey indices continue to reflect a moderate increase in pollock biomass in Subarea 5 due to improved recruitment (Figure 6).

### 5. **White Hake**

USA landings of white hake (*Urophycis tenuis*) decreased by 22% from 4,434 mt in 2003 to 3,461 mt in 2004. Research vessel survey indices declined during the 1990s, increased in 2000 and 2001 due to good recruitment of the 1998 year-class, and have since declined (Figure 7).

### 6. **Yellowtail Flounder**

USA landings of yellowtail flounder (*Limanda ferruginea*) increased 35% from 5,327 mt in 2003 to 7,202 mt in 2004. Research vessel survey indices suggest that the Georges Bank stock (Div. 5Z, E of 69E) is at a moderate to high biomass level, while the Southern New England-Mid Atlantic stock (Div. 5Z W of 69E and SA 6) remains at an historic low (Figures 8 and 9).

### 7. **Other Flounders**

USA commercial landings of flounders (other than yellowtail flounder) from Subareas 3-6 in 2004 totaled 17,403 mt, 3% lower than in 2003. Summer flounder (*Paralichthys dentatus*) (45%), winter flounder (*Pseudopleuronectes americanus*) (28%), witch flounder (*Glyptocephalus cynoglossus*) (17%), American plaice (*Hippoglossoides platessoides*) (10%), and windowpane flounder (*Scophthalmus aquosus*) (<1%) accounted for virtually all of the 'other flounder' landings in 2004. Compared to 2003, commercial landings in 2004 were higher for windowpane flounder (32%) and summer flounder (21%), but lower for American plaice (-30%), winter flounder (-17%) and witch flounder (-6%). Research vessel survey indices in 2004 increased for witch flounder, decreased for American plaice, winter flounder and windowpane, and remained relatively constant for summer flounder (Figures 10-14).

### 8. **Silver hake**

USA landings of silver hake (*Merluccius bilinearis*) decreased by 24% from 8,648 mt in 2003 to 6,557 mt in 2004. 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*) declined 36% from 809 mt in 2003 to 519 mt in 2004. 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, but markedly declined in 2004 (Figure 17). Indices for the Southern Georges Bank - Mid-Atlantic stock, however, continue to remain at record-low levels (Figure 18) despite low landings.

## 10. Atlantic Herring

Total USA landings of Atlantic herring (*Clupea harengus*) decreased 7% from 100,836 mt in 2003 to 94,250 mt in 2004. Spawning biomass of the coastal stock complex has increased since 1982 and is currently well above the high levels observed in the late 1960s. Stock size has increased due to both strong recruitment and reduced fishing mortality on both adult and juvenile herring. There is strong evidence of stock recovery on Georges Bank (Div. 5Ze) based on research vessel abundance indices. Commercial landings from Georges Bank decreased 55% from 19,859 mt in 2003 to 8,917 mt in 2004.

## 11. Atlantic Mackerel

USA commercial landings of Atlantic mackerel (*Scomber scombrus*) increased 53% from 34,292 mt in 2003 to 52,490 mt in 2004. Recreational catch declined 36% from 724 mt in 2003 to 467 mt in 2004. Based on research vessel survey indices, total stock biomass remains large. Stock rebuilding since 1981 has resulted from very low fishing mortality rates and the recruitment of several good year-classes (1982, 1987, 1988, 1991, and most year-classes from 1993 to present).

## 12. Butterfish

USA landings of butterfish (*Peprilus triacanthus*) declined 65% from 468 mt in 2003 to 166 mt in 2004, most likely due to reduced market demand. Research vessel survey biomass indices increased during the late 1970s, fluctuated during the 1980s, and are presently below the long-term average.

## 13. Squids

USA landings of longfin inshore squid (*Loligo pealii*) during 2004 were 13,331 mt, 12% higher than in 2003 (11,943 mt). The NEFSC autumn survey biomass index has fluctuated without long-term trend (Figure 20).

Following a period of low landings during 1999-2003 (ranging from 2,750 mt to 9,011 mt), USA landings of northern shortfin squid (*Illex illecebrosus*) reached a record-high in 2004 (25,226 mt) and the fishery was closed in September after the annual quota of 24,000 mt was attained. NEFSC autumn survey abundance index in 2003 was a record-high (Figure 19), but in 2004, the survey index (5.1 squid per tow) returned to the low levels observed during 1999-2003 and the average weight of individual squid in the 2004 autumn survey remained low (82 g) and within the range observed since 2001.

## 14. Sea Scallops

USA sea scallop (*Placopecten magellanicus*) landings in 2004 were a record-high 28,714 mt (meats), 14% above the previous record-high attained in 2003 (25,106 mt). The bulk of the 2004 landings (85% or 24,530 mt) was harvested from the Mid-Atlantic region, where landings reached a new record level for the fifth consecutive year. The high landings in this region are due to unusually strong recruitment over the last seven years together with reduced fishing mortality that has improved yield-per-recruit.

Research vessel surveys in 2004 indicated continued high biomass in both the Georges Bank and Mid-Atlantic regions (Figures 21 and 22). A substantial portion of the sea scallop biomass in the Georges Bank region is located in the three groundfish closure areas that have been closed to scallop fishing for most of the time since December 1994. However, increases in biomass outside these areas have also occurred. Recruitment in 2004 was strong in the Mid-Atlantic, especially off of New Jersey and Delaware, where a new rotational sea scallop closed area was implemented in 2004. Recruitment in 2004 was below average on Georges Bank.

## 15. Small Elasmobranchs

USA landings of spiny dogfish (*Squalus acanthias*) declined by 51% from 1,170 mt in 2003 to 591 mt in 2004, largely due to spiny dogfish landings restrictions. Survey indices are highly variable but have generally declined since the early 1990s (Figure 23).

USA landings of skates (80% landed as unclassified) declined by 24% between 2003 and 2004 from 15,003 mt to 11,355 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 24) and subsequently declined possibly due to an increase in the directed fishery in the 1990s. Since the mid-1990s, the indices have been stable at an intermediate level. Little skate (*Leucoraja erinacea*) survey indices have generally fluctuated without trend (Figure 25). 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 magnitude as in the mid-1960s (Figure 26). Thorny skate (*Amblyraja radiata*) survey indices have declined over the entire time series and are currently near record lows (Figure 27). 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 27). Indices for both clearnose skate (*Raja eglanteria*) and rosette skate (*Leucoraja garmani*) have generally increased over the time series (Figures 29 and 30).

## B. Special Research Studies

### 1. Environmental Studies

#### a) Hydrographic Studies

During 2004 over 1830 CTD (conductivity, temperature, depth) profiles were made on NEFSC cruises. The data were processed and made available via an anonymous FTP site. A report on the oceanographic conditions indicated by these observations is available via the NEFSC website at <http://www.nefsc.noaa.gov/nefsc/publications/crd/crd0503>. Similar reports have been issued each year since 1991.

#### b) Plankton Studies

During 2004, zooplankton community distribution and abundance was monitored using 606 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 twelve transects across the Gulf of Maine from Cape Sable, NS to Boston and nine 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. On a November 2004 cruise, three objectives were met. First, gravel habitats on northern Georges Bank which have been sampled numerous times since one portion of the area was closed to fishing in 1994 were revisited. In the closed area, emergent epifauna such as sponges and bryozoans were still present but less abundant than in the prior several years, while in the fished area the bottom remained mostly bare gravel. The closed area had higher abundances of sea scallops, sea stars, red hake, sea urchins, waved whelks and hermit crabs. Second, stations that had been occupied a year earlier, just inside and outside the boundaries of the Nantucket Lightship Closed Area (southeast of Cape Cod) were re-sampled to study effects on substrates and benthos of fishing as well as effects of habitat features (e. g., sand ridges vs. swales) on benthic assemblages. As in 2003, there were again indications of substantially higher biomass and numbers of individuals and species inside the closed area. The fauna there was characterized by sponges, sea stars, scallops and other mollusks, red hake and other fishes. Stations outside the NLCA had smaller numbers of the same species, with sand dollars being the only abundant species. Finally, it was documented that an invasive tunicate, *Didemnum lahillei*, is now abundant over at least 40 square miles of gravel substrate on northern Georges Bank. 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 tunicate species had been present in the area prior to 2002, but had not been noticed. Analysis of seabed video and still photos indicated that in fall 2002 the species occupied at most 10% of the bottom in a few areas, while in 2003 in some places it covered up to 90% of the bottom, over at least a 6.5 square mile area. There is some evidence that benthic community composition is changing in areas where the tunicate is abundant. Groundfish survey cruises have been

alerted to look for this species in other areas, and a summer 2005 cruise will continue to monitor its areal extent and ecological effects.

Inshore studies of habitat requirements of resource species and studies of fishing gear effects on habitat were continued. The commercially important hard clam, *Mercenaria mercenaria*, is abundant in Raritan Bay (NY/NJ), especially where amphipod tubes (*Ampelisca* spp.) are a dominant feature of the bottom. The extent of the tubes over space and time is being documented and attempts are being made to determine whether settling of larval hard clams and other benthos is related to whether the tubes are recently formed or are older. In an area with a winter dredge fishery for blue crabs, *Callinectes sapidus*, effects of a commercial crab rake on the tube beds and other habitat features are being documented. A cooperative project to restore oyster reefs in local estuaries and to determine functional value of the reefs to resource species is underway. A manuscript on justification for controlling sea lettuce, *Ulva lactuca*, in estuaries was completed as well as an MS on the poor prospects for developing aquaculture projects on the US east coast.

#### d) **Other Environmental Studies**

**Essential Fish Habitat Projects:** Several field studies were conducted to collect information on Level-3 EFH data. These data use environmental variables to understand habitat suitability and distribution of fishes and their life-history stages. These studies were supplemented by experimental investigations in the laboratory, using observation tanks. Species of particular interest include American lobster, blue crab, winter flounder, tomcod, weakfish, bluefish, summer flounder and black sea bass.

Progress continues on a project to study settlement and early-life history of fishes that utilize hard-substrate rock reef as habitat. Minnow traps have been successfully deployed to sample settling young-of-the-year tautog, cunner, and black sea bass. On-reef and off-reef sites were sampled concurrently and settling fishes are clearly associated with the reef. Young lobster, sampled in traps, have been tagged and appear to be associated with specific locations on the reef. Site characterization data have been incorporated in GIS mapping and kriging of catch data has provided a graphic visualization of habitat use. The reef appears to be an important habitat, supporting a large abundance and diversity of young fishes and invertebrates.

Sampling of young-of-the-year fishes continues in a nursery area in the shallow waters of Morris Cove in New Haven, Connecticut. Differential use of specific habitat types by different fish species has been established, and attempts will be made to link annual abundance of young-of-the-year fishes to adult species abundance in Long Island Sound. Efforts to sample winter flounder eggs and late larvae in coastal waters were successful and data are being analyzed to identify and characterize spawning areas.

## 2. **Biological Studies**

### a) **Fish Species**

**Flatfishes:** Four themes are being addressed in studies of summer flounder, *Paralichthys dentatus*: 1) the effects of winter temperature regimes on growth, development, and mortality rates of eggs, larvae, and juveniles; 2) the role of time and location of spawning on winter survival of larvae and spring-summer growth of juveniles; 3) mortality risks of recently settled juveniles due to predation by bay shrimp (*Crangon septemspinosa*), blue crab (*Callinectes sapidus*), and larger summer flounder juveniles; and 4) rates of change of stable isotope ratios as indicators of prey consumed, and the potential of these ratios for evaluation of fish habitat usage.

**Gadids:** Field and laboratory research continues on Atlantic tomcod *Microgadus tomcod*, a locally abundant inshore gadid. Tomcod has a 1-yr life cycle, is an important forage fish, and serves as a sentry of habitat and fish community health in the Hudson River Estuary (New York, USA). Two concurrent projects on tomcod are underway that address ecological and toxicological themes. Regarding the ecological theme, estimates are being obtained on: 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 rate of dioxin and locally occurring (Hudson River) congeners of PCBs; 2) sublethal toxic responses to graded doses of local PCBs congeners using captive (F<sub>1</sub> and F<sub>2</sub>) tomcod populations; and 3) interactions between environmental stressors, i.e., PCBs and high summer temperatures.

**Goosefish:** Three themes are being investigated in studies of goosefish, *Lophius americanus*: 1) seasonal and inter-annual patterns of variation in body components focusing on the relationship between gonad size (reproductive effort) and liver size in the previous year; 2) temperature-dependent growth, developmental, and survival rates of the early life-stage goosefish from captive-spawned egg veils; and 3) movement, feeding, and spawning behavior of captive, wild-caught adult goosefish.

**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); 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.

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

**Aquaculture Projects:** Black sea bass spawned in season in 2002 have grown to 178 mm, 202 mm, and 237 mm in two years. These fish, held in a temperature controlled recirculating system, have produced gametes. The spawning of black sea bass at their normal spawning time in 2004 has been the most successful to date. The 2004 spawn resulted in the production of 10,000 juvenile black sea bass.

**Other Projects:** During summer 2004, two NEFSC scientists participated in the first major field phase of MAR-ECO, an international Census of Marine Life (CML) project to explore the patterns and processes of the northern Mid-Atlantic Ridge, from the area between the Azores and Iceland. Bottom trawling, midwater trawling and ROV work were conducted to evaluate fish and cephalopod diversity and distribution patterns. This project is one of many in the CML program which involves researchers from 16 countries. In addition collaborative work is planned using data from NEFSC cruises to Bear Seamount.

#### b) **Resource Surveys Cruises**

During 2004, personnel from the Ecosystems Surveys Branch (ESB) staged, staffed and supported the winter, spring and fall bottom trawl surveys as well as the northern shrimp, sea scallop, fishing power, hydroacoustic Atlantic herring and gear experiment surveys for a total of 630 staff sea days with an additional 175 staff sea days spent on non-ESB surveys. A total of 1596 stations were occupied in an area extending from Cape Hatteras, North Carolina to Nova Scotia including the Gulf of Maine. 83,756 length frequencies were taken from 268 species during these cruises.

Significant sampling effort was also expended to fulfill requests from 47 NMFS and University investigators for samples or observations made during the various survey cruises. These included 14,943 feeding ecology observations, 22,430 aging structures collected, and 13,523 samples or specimens collected

Significant progress was made toward the complete documentation (including detailed diagrams) of the two nets used during NEFSC seasonal bottom trawl surveys: the Yankee 36 with roller gear and the other with a cookie sweep. Memorial University has worked closely with staff to develop this final product. A new net and new set of doors which will be used when the new research vessel, Henry B. Bigelow, arrives in 2006 has been under development and was tested during 2004 in cooperation with

leading industry and commercial stakeholders.

c) **Age and Growth**

Approximately 36,000 age determinations for 8 species of finfish were completed in 2004 by Woods Hole Laboratory staff in support of resource assessment analyses and other research. In addition to Atlantic cod (6,345), haddock (5,141), and yellowtail flounder (11,384), 2,404 scup, 3,262 summer flounder, and 6,171 monkfish were aged.

Cod and haddock age structures were exchanged with age readers from Canada's Department of Fisheries & Oceans St. Andrews Biological Station, and ageing materials for Atlantic herring were exchanged with readers from USA state laboratories in a continuing effort to maintain comparability of age determinations between laboratories.

Research projects initiated or continued in 2004 included: (1) a study examining possible Closed Area effects on growth rates and age-class distribution of yellowtail flounder; (2) compilation of information related to stock reproductive potential; (3) a study of the biology and origin of witch flounder *Glyptocephalus cynoglossus* in deep water habitats; (4) a study of the biology of offshore populations of cunner *Tautoglabrus adspersus*; (5) development of an indirect age estimation method based on otolith weight for butterfish *Peprilus triacanthus*; and (6) completion of scale reference collections for three stocks of yellowtail flounder.

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 2004 winter survey, 3,938 stomachs from 39 species were examined, while 5,733 stomachs from 46 species, and 5,272 stomachs from 44 species were examined during the spring and autumn 2004 surveys, respectively. Diet sampling emphasized small pelagics, elasmobranchs, gadids, flatfishes, and lesser known species.

The 32 year time series (1973-2004) 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 450,000 stomach samples. The processing of the 2004 and 2005 bottom trawl survey food habits data is scheduled for completion in 2005.

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 (CSTP), 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 2004. These efforts formed the basis for NMFS essential fish habitat designations in the Fishery Management Plan for Atlantic Tunas, Swordfish, and Sharks. In 2004, EFH was re-designated for 44 highly migratory species using these data.

A bi-annual fishery independent survey of Atlantic large and small coastal sharks in US waters from Florida to Delaware was conducted in 2004. The goals of this survey were to: 1) monitor the species composition, distribution, and abundance of sharks in the coastal Atlantic; 2) tag sharks for migration

studies; 3) collect biological samples for age and growth, feeding ecology, and reproductive studies; 4) tag sharks whenever feasible for age validation studies; and 5) collect morphometric data for other studies. Results from the 2004 survey included 589 fish representing 17 species caught on 69 longline sets. The time series of abundance indices from this survey are critical to the evaluation of coastal Atlantic shark species.

Biological research on pelagic shark species in 2004 included age studies of the white shark, *Carcharodon carcharias*, and the thresher shark, *Alopias vulpinus*, and re-examination of the age and growth of the shortfin mako, *Isurus oxyrinchus*. A manuscript was prepared on validated age and growth of the shortfin mako and is now under review. Unvalidated age of the thresher shark has been completed as a Masters Thesis and is being reformatted for publication. Work on the white shark is continuing with vertebrae, length-frequency data, and tag/recapture data collected between 1962 and 2004 being analyzed to obtain growth function parameters. In conjunction with staff at the Moss Landing Marine Laboratory, bomb radiocarbon dating techniques are being used to validate band periodicity.

Reproductive dynamics and nursery ground studies also continued, focusing on the identification and characterization of mating, pupping, and nursery areas of small and large coastal sharks along the Atlantic coast of the US. An ongoing project to study the diet, gastric evacuation, and feeding ecology of elasmobranchs in the Delaware Bay nursery will quantify the food and feeding characteristics of juvenile sandbar sharks, *Carcharhinus plumbeus*, and smooth dogfish, *Mustelus canis*, and assess ontogenetic changes within both species and dietary overlap between the two species. Stomachs from over 800 sandbar sharks and over 200 smooth dogfish sharks have been sampled for contents through a non-lethal lavage method. Acquired data will be coupled with environmental data, providing information on preferred habitat. Random stratified sampling based on depth and geographic location continued towards developing 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. In addition, staff are editing an American Fisheries Society symposium proceedings volume on U.S. Atlantic and Gulf of Mexico coastal shark nursery ground and habitat studies.

A collaborative program examining the biology and population dynamics of the blue shark, *Prionace glauca*, in the North Atlantic continued in 2004. Research on the food and feeding ecology of the blue shark is being conducted cooperatively with University of Rhode Island staff with additional samples collected and a manuscript under revision. A detailed reexamination of the reproductive parameters of the blue shark continued with collection of additional biological samples to determine if any changes have occurred since the 1970s. A manuscript on blue shark stock structure based on tagging data was completed detailing size composition and movements between Atlantic regions. Additionally, research efforts continued between NEFSC scientists and scientists at the School of Aquatic and Fishery Sciences, University of Washington on blue shark population dynamics in the North Atlantic with the objectives of constructing a time series of blue shark catch rates (CPUE) from research surveys, estimation of blue shark migration and survival rates, and the development of an integrated tagging and population dynamics model for the North Atlantic for use in stock assessments.

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. Analysis of these tournament landings data was initiated by creating a database of historic information (1961-2004) and producing preliminary summaries of one long-term tournament. The collection and analysis of these data are critical for input into species and age specific population and demographic models for shark management

#### f) **Marine Mammals**

**Small Cetaceans:** The NEFSC used the *R/V Endeavor* and NOAA Twin Otter during 12 June to 4 August 2004 to conduct a line transect sighting survey of small cetaceans in Northwest Atlantic waters from Virginia to Nova Scotia. This survey was conducted in conjunction with the Southeast Fisheries Science Center, which conducted a line transect sighting survey from Virginia to Florida. The primary objective was to estimate the abundance of small and large cetaceans and turtles. On the shipboard survey, secondary objectives included: determine the distribution and relative abundance of sea birds



in the same region, and use passive acoustics to record vocalizing cetaceans to improve the abundance estimates derived from sighting surveys. The aerial survey covered 6907 km and the shipboard survey covered 3176 km of track line.

During 6-23 July 2004, the NOAA *R/V Delaware II* was used to biopsy and photograph pilot whales (*Globicephala* spp.) from the southern extreme of Georges Bank to Cape Hatteras, North Carolina. Collected tissues will be used to determine the distribution and geographic overlap of long-finned (*Globicephala 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 would be useful [*e.g.* sperm whales (*Physeter catodon*) and striped dolphins (*Stenella* spp.)].

Incidental by-catches of cetacean, turtle, and seal species that were observed taken in commercial fisheries from Maine to North Carolina were calculated. Fisheries observed during 2004 include: gill nets, otter trawls, mid-water otter trawls, mid-water pair trawls, scallop trawls, scallop dredges, clam dredges, purse seines, beach seine, Scottish seines, bottom longline, pound nets, hand-line, and some pot and traps. Cetaceans observed taken include: harbor porpoises, bottlenose dolphins, common dolphins, white-sided dolphins, and pilot whales. In addition, incidental fishery takes of harbor seals, grey seals, harp seals, hooded seals, loggerhead turtles, green turtles, and leatherback turtles were observed.

**Large Cetaceans:** During 15 January-13 March 2004, NEFSC and SEFSC staff conducted a biopsy and photo-id survey of large cetaceans on Silver Bank off the Dominican Republic using the *R/V Gordon Gunter*. Silver Bank is an important breeding and calving area for much of the North Atlantic humpback whale population and the survey was the second in two field seasons to estimate the population of whales on Silver Bank.

The NEFSC, in conjunction with the Woods Hole Oceanographic Institution, conducted a habitat sampling and tagging study to aide in understanding right whale foraging behavior in the Great South Channel area off Massachusetts, USA.

During March-June and September-December 2004, 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. The NEFSC also conducted a four-week biopsy and photo-id research cruise in the Gulf of Maine and Scotian Shelf region in August 2004 as part of a large-scale assessment of North Atlantic humpback whales.

Scarification analyses of right and humpback whales continued in 2004. These analyses are used to monitor interactions between whales and fishing gear.

The North Atlantic Right Whale Individual ID catalogue and database (NE Aquarium and URI) were updated through December 2004.

**Pinnipeds:** A total of four aerial surveys were conducted in winter 2004 of the gray seal pupping sites (Muskeget Island in Nantucket Sound ; Seal and Green Islands in eastern Maine). A minimum of 1000 pups was observed.

In February 2004, NEFSC scientific staff along with researchers from a variety of institutions and universities participated in the live capture, biological sampling, and tagging of weaned gray seal pups on Green Island. Fifteen pups were captured and biological sampling included: weight (kg), length (cm), sex, and flipper tagged using ALLFLEX tags imprinted with a unique identifier and contact information. The tissue samples obtained when attaching the flipper tag were kept for genetic analysis. One female pup was satellite tagged. Her tag did not immediately start transmitting so information on her movements were available from ~May to November. This pup spent much of the spring and summer in Nantucket Sound and then moved off the southwest tip of Nova Scotia in the fall where she remained until the tag stopped transmitting.

In October 2002, the NEFSC let a contract to the Woods Hole Oceanographic Institution to process stomachs obtained from seals that are taken incidentally in the New England sink gillnet fisheries. The report on the 2004 findings is under review.

g) **Turtles**

The NEFSC collaborated with several academic and industry groups to assess and reduce sea turtle by-catch in domestic commercial fisheries in the Northwest Atlantic Ocean.

NEFSC addressed sea turtle by-catch in the USA sea scallop dredge fishery through by-catch analysis and gear research. Observer coverage of commercial vessels in the 2003 U.S. sea scallop dredge fishery was used to estimate by-catch of sea turtles during 1 June to 30 November 2003 in the Mid-Atlantic region. The study utilized a General Linear Model and Generalized Additive Model fitting techniques to identify environmental factors and gear characteristics that influence by-catch rates of sea turtles. Based on industry and academic input, the Center funded studies to evaluate the use of chain mats to exclude turtles from entering sea scallop dredges. The NEFSC is continuing to work with scallop fishing industry participants to better observe, analyze, and mitigate turtle-dredge interactions.

The NEFSC is addressing high sea turtle strandings in coastal Virginia by assigning observer coverage to multiple fisheries and simultaneously undertaking gear research in the pound net fishery in Chesapeake Bay. In May and June 2004, a 42-day study was conducted to test a pound net leader which had been modified to reduce the likelihood of sea turtle interactions. During the study, both standard leaders and modified leaders were fished in close proximity, and sea turtle and fish catch were recorded. During the fall of 2004, the results were analyzed and the leader was further modified to continue to reduce the likelihood of turtle interactions with fishing gear.

### 3. Studies of Fishing Operations

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

The NEFSC deployed observers on 1,459 commercial fishing trips with a total of 6,045 gear retrievals in the New England and Mid-Atlantic gillnet fisheries. Primary objectives were to monitor the incidental by-catch of marine mammals and sea turtles. A total of 119 marine mammals were caught, including (in order of highest occurrence) harbor seals, harbor porpoises, gray seals, and harp seals. Six turtles were taken, including one green turtle, two leatherback turtles and three loggerhead turtles. From most of the animals, biological samples were collected including body weight measurements, tissue samples, or collection of the entire animal. A total of 40 seabirds were also caught.

b) **Float Drift Gillnet Fisheries**

The closure of the pelagic swordfish drift gillnet fishery continued in 2004. Thirty-four trips were observed with a total of 125 gear retrievals. Kept and discarded finfish were weighed or estimated for a portion of the observed sets. Length frequencies and age structures were also obtained from the finfish. Protected species, endangered species or seabird takes in this fishery consisted of one leatherback turtle and one unidentified turtle

c) **Otter Trawl Fisheries**

A total of 1172 trips were observed with a total of 10,752 gear retrievals. Kept and discarded catches were weighed or estimated. Length frequencies and age structures were obtained for age and growth studies. Thirty-eight marine mammals, four loggerhead turtles and 13 seabirds were incidentally caught in the otter trawl fisheries.

d) **Sea Scallop Fisheries**

In 2004, 344 trips were observed with a total of 27,309 gear retrievals. The scallop catches were measured and weighed. The finfish by-catch was also weighed, and size frequency and age structure data collected from a portion of the hauls. Nine loggerhead turtles and two marine mammals (one moderately decomposed and one severely decomposed) were caught. Four seabirds were taken.

e) **Conch Pot Fishery**

No conch pot trips were observed in 2004.

f) **Scottish Seine Fishery**

Observers covered eight trips with a total of 29 gear retrievals in the Scottish seine fishery in 2004. Kept and discarded finfish were weighed or estimated for a portion of the observed set. Length frequencies and age structures from the finfish catch were also obtained. No protected or endangered species were observed taken in this fishery.

g) **Sink Drift Gillnet**

NEFSC observers covered 248 trips with a total of 1,158 gear retrievals in 2004. Kept and discarded finfish were weighed or estimated for a portion of the observed sets. Length frequencies and age structures were also obtained from the finfish catch. One whitesided dolphin and nine harbor seals were observed taken. Eighteen greater shearwaters were caught.

h) **Midwater Pair Trawl**

Ninety-five trips with a total of 221 gear retrievals were observed in 2004. Kept and discarded finfish were weighed or estimated for a portion of the observed sets. Length frequencies and age structures were also obtained from the finfish catch. No protected or endangered species were observed taken in this fishery. Twenty-two northern gannets were caught.

i) **Bottom Longline Fishery**

In 2004, observers were deployed on 129 bottom longline trips with a total of 579 gear retrievals. Kept and discarded finfish were weighed or estimated for a portion of the observed sets. Length frequencies and age structures were also obtained from the finfish catch. No protected or endangered species were observed taken in this fishery. Four seabirds were caught.

j) **Beach Haul Seine**

Thirty-six trips with a total of 36 gear retrievals were observed in this fishery in 2004. Kept and discarded finfish were weighed or estimated for a portion of the observed sets. Length frequencies and age structures were also obtained from the finfish catch. No protected or endangered species were observed taken in this fishery. Sixteen seabirds were taken including one red-throated loon and 15 northern gannets.

k) **Pound Net**

No pound net trips were observed in 2004.

l) **Handline**

Seven trips with a total of 43 gear retrievals were observed in this fishery in 2004. Kept and discarded finfish were weighed or estimated for a portion of the observed sets. Length frequencies and age structures were also obtained from the finfish catch. No protected or endangered species were observed taken in this fishery.

m) **Herring Purse Seine**

Thirty trips with a total of 57 gear retrievals were observed in this fishery in 2004. Kept and discarded finfish were weighed or estimated for a portion of the observed sets. Length frequencies and age structures were also obtained from the finfish catch. Thirty-one seals were caught in this fishery (five seal NK, 11 harbor seals and 15 gray seals) and were all released alive.

n) **Lobster Pot**

Two trips with a total of 15 gear retrievals were observed in this fishery in 2004. Kept and discarded finfish were weighed or estimated for a portion of the observed sets. Length frequencies and age structures were also obtained from the finfish catch. No protected or endangered species were observed taken in this fishery.

o) **Fish Pot**

Eight trips with a total of 114 gear retrievals were observed in this fishery in 2004. Kept and discarded finfish were weighed or estimated for a portion of the observed sets. Length frequencies and age structures were also obtained from the finfish catch. No protected or endangered species were observed taken 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 domestic peer review process termed the 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 occurred for several years). The SAW reviews about 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 2004 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 is being conducted on the remaining Atlantic salmon populations in the State. 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 2004 focused on obtaining smolt production estimates, telemetry studies of emigrating hatchery and wild smolts, fishery-independent sampling through marine smolt trawling surveys 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 precise 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 analysis of the data from these studies has identified differential migration success in relation to stocking location and time. The effect that stocking location and time has 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 further investigated through follow-up studies. A fishery-independent trawl survey, incorporating a modified Norwegian designed trawl net with a hard cod-end aquarium for live capture and release

capabilities, has allowed researchers to obtain specimens from the marine environment. Samples obtained from this survey will be used to estimate population abundance in the nearshore environment as well as evaluate the physiological health and condition of these fish. Monitoring the West Greenland fishery and collecting biological data and statistic continued as well. These data are provided directly to ICES and are required for North American run-reconstruction modeling and catch advice generation for this fishery. All of these studies will contribute to recommendations for additional measures to be considered to halt the decline and restore the resource.

**b) Cooperative Research with the Fishing Industry**

**Study Fleet:** A pilot study fleet program comprised of 33 Southern New England and Gulf of Maine vessels has been implemented. An electronic logbook capable of collecting high-resolution spatial and temporal information on individual hauls, or tows, has been developed and deployed on a variety of fleets. Data collected from these logbooks are satellite transmitted from the vessel to a shore-side database allowing for near-real time (minimum delay of 1 day) analysis of fishery-dependent data. To date, data have been collected from more than 850 individual trips, accounting for more than 1,089 mt (live weight) of landings.

Continued developments of this project will emphasize its utility as a stock assessment and fishery-reporting tool. A top priority will be integration of the Study Fleet program with the existing biological port sampling program to improve the precision of biological samples. The use of temperature probes on study fleet vessels to collect sea temperature will be expanded.

**Gear Modification Studies:** During January of 2004, two *Loligo* fishing vessels were chartered by the NEFSC to investigate the effectiveness of a large-mesh panel in reducing finfish by-catch in the small-mesh *Loligo* fishery. Extreme weather conditions resulted in a reduced number of stations sampled during the parallel haul study. However, the results indicated that the net configuration reduced the amount of scup and black sea bass by-catch, but will require reconfiguration to reduce the loss of *Loligo*, the target species.

**Tagging Studies:** The Cooperative Black Sea Bass Tagging Project was designed to examine the population size, exploitation rate and seasonal movements of the northern Atlantic coast population of black sea bass, *Centropristis striata*. This project is conducted in collaboration with state fishery agencies, and with commercial and recreational fishermen. Since autumn 2002, federal and state fishery employees have tagged and released 13,688 black sea bass from Cape Cod, Massachusetts to Cape Henry, Virginia with recaptures exceeding 2,028 fish. In addition, sea bass have been released with data storage tags to examine depth and temperature experienced during seasonal migrations.

In 2004, in a cooperative research project involving yellowtail flounder fishermen, another 20,000 yellowtail flounder were tagged from the Gulf of Maine to the Mid Atlantic, 244 of which were tagged with data-storage tags. A total of 28,000 fish were previously tagged in 2003 and 2004. As of April 2005, tags have been returned from 1600 recaptured fish. Preliminary results indicate a low frequency of movement among management areas. Thirty-two data-storage tags have been returned, indicating distinct off-bottom movements.

**Industry-Based Surveys:** An industry-based survey for monkfish (*Lophius americanus*) was conducted using a commercial stern trawler during March-June, 2004. The survey covered U.S. waters from Cape Hatteras through the Gulf of Maine, and used a stratified random design with sampling effort proportional to recent fishing effort. The purpose of the survey is to provide information on abundance, distribution, and biology of monkfish, as this species is not well sampled by the gear used in NMFS standard fall and spring bottom trawl surveys. A total of 255 stations were successfully sampled, with almost 7,000 monkfish captured (~14.5 mt). Analysis of the data is not yet finalized; however, preliminary results are consistent with trends in monkfish abundance seen in the NMFS surveys.

**c) Stock Assessment Methods Development**

Many national and international studies have concluded that stock assessments should consider evaluating 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).

d) **Other Research**

A method was developed to optimize the allocation of available sea days for observer coverage to minimize either the variance of discard estimates or the number of sea days for a discrete set of fisheries. This was done using existing observer and vessel trip report data binned into 227 separate fisheries or strata. The model currently works on an aggregate Discard/Kept ratio but may be modified in the future to also work with Discard/Effort ratios.

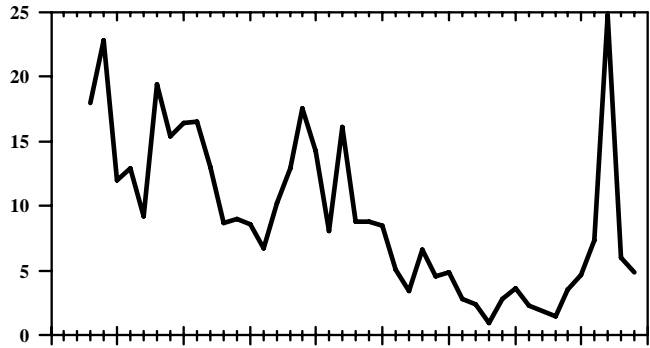


Figure 1. NEFSC autumn bottom trawl survey biomass indices for Gulf of Maine cod.

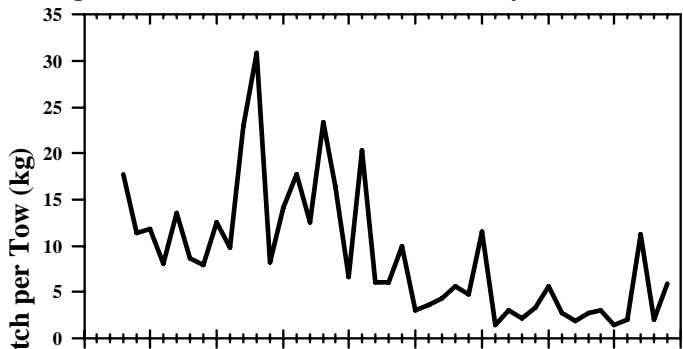


Figure 2. NEFSC autumn bottom trawl survey biomass indices for Georges Bank cod.

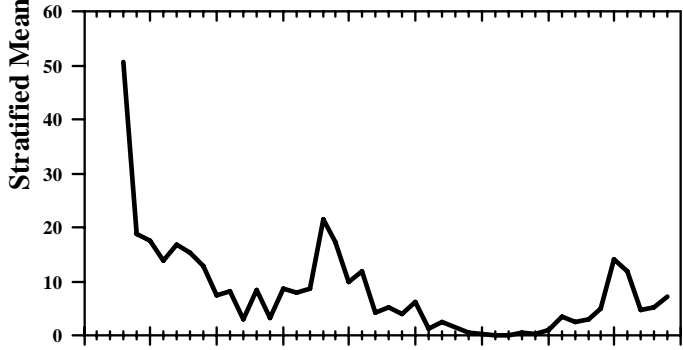


Figure 3. NEFSC autumn bottom trawl survey biomass indices for Gulf of Maine haddock.

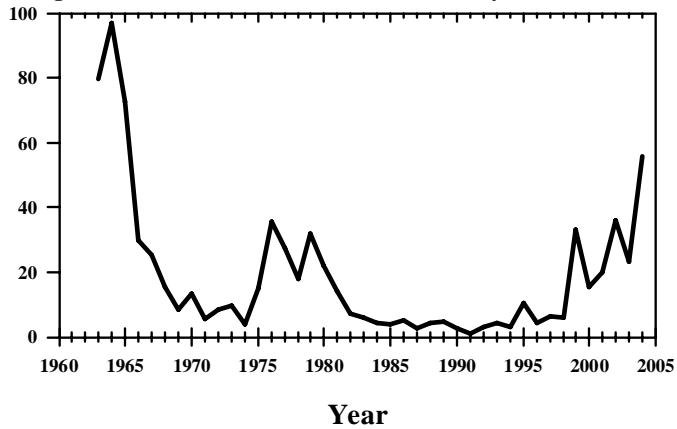


Figure 4. NEFSC autumn bottom trawl survey biomass indices for Georges Bank haddock.

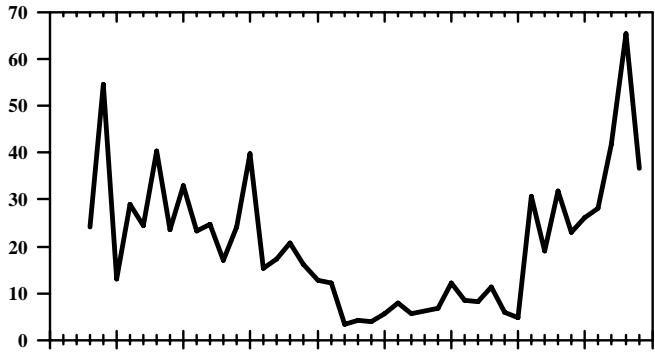


Figure 5. NEFSC autumn bottom trawl survey biomass indices for redfish.

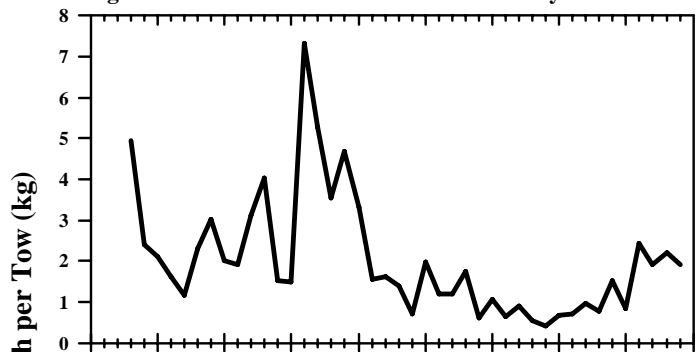


Figure 6. NEFSC autumn bottom trawl survey biomass indices for pollock.

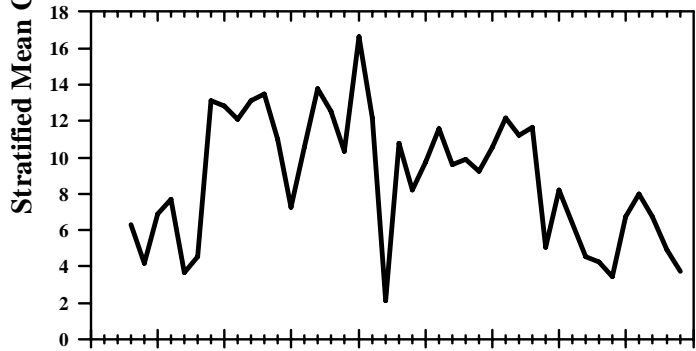


Figure 7. NEFSC autumn bottom trawl survey biomass indices for white hake.

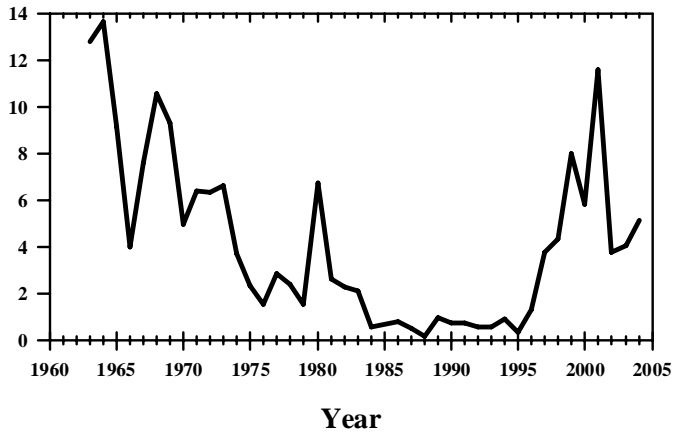


Figure 8. NEFSC autumn bottom trawl survey biomass indices for Georges Bank yellowtail flounder.



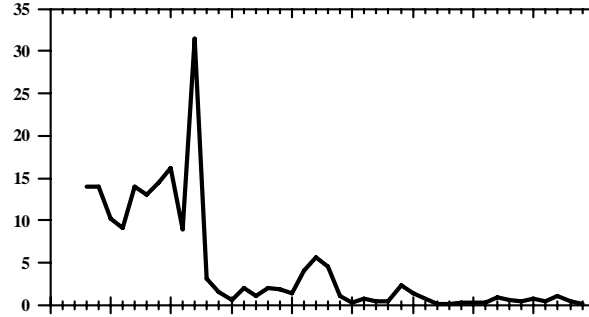


Figure 9. NEFSC autumn bottom trawl survey biomass indices for Southern New England-Mid-Atlantic yellowtail flounder.

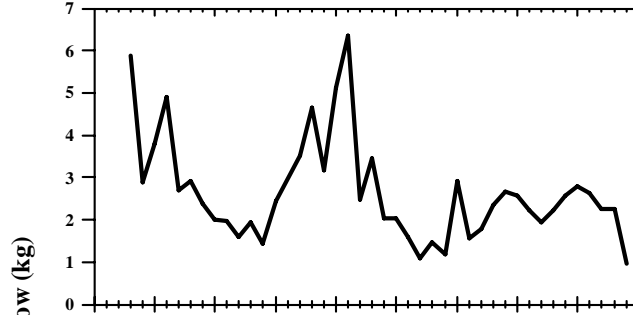


Figure 10. NEFSC autumn bottom trawl survey biomass indices for American plaice.

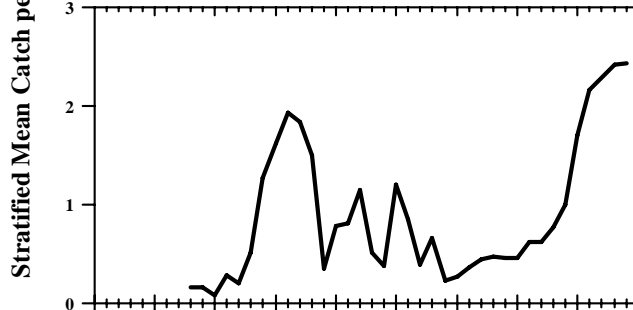


Figure 11. NEFSC spring bottom trawl survey biomass indices for summer flounder.

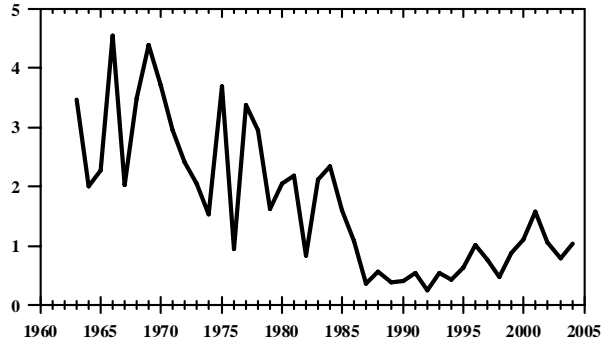


Figure 12. NEFSC autumn bottom trawl survey biomass indices for witch flounder.

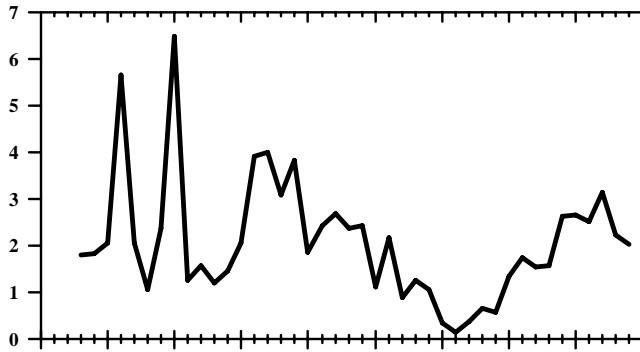


Figure 13. NEFSC autumn bottom trawl survey biomass indices for Georges Bank winter flounder.

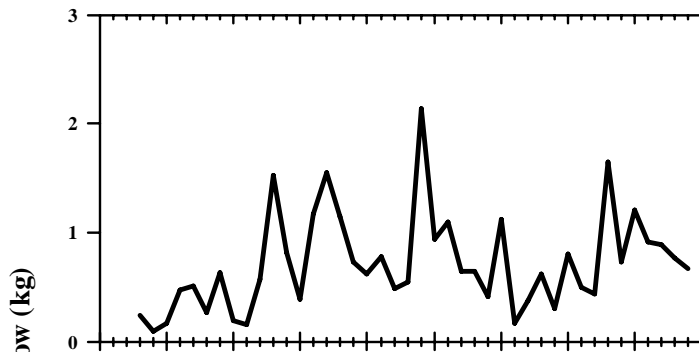


Figure 14. NEFSC autumn bottom trawl survey biomass indices for northern windowpane flounder.

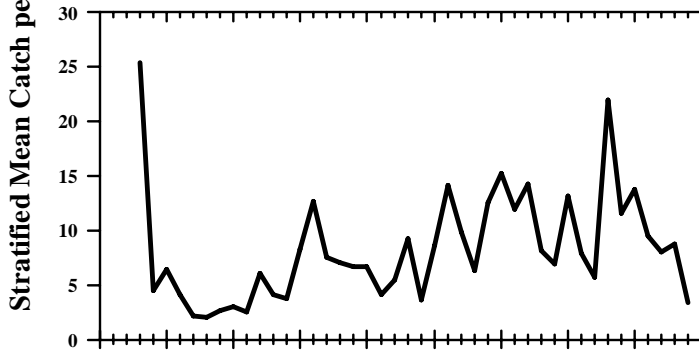


Figure 15. NEFSC autumn bottom trawl survey biomass indices for northern silver hake.

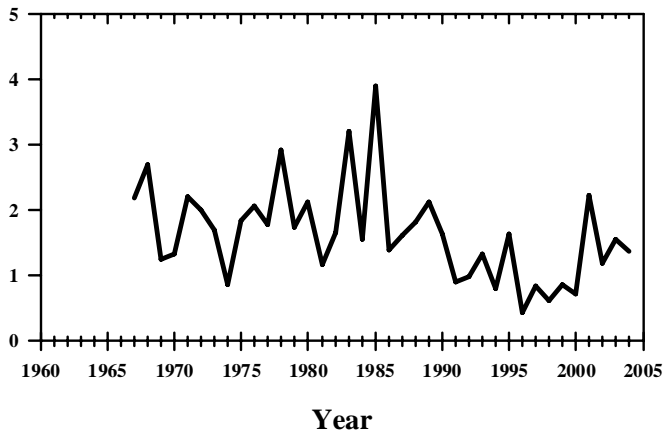


Figure 16. NEFSC autumn bottom trawl survey biomass indices for southern silver hake.

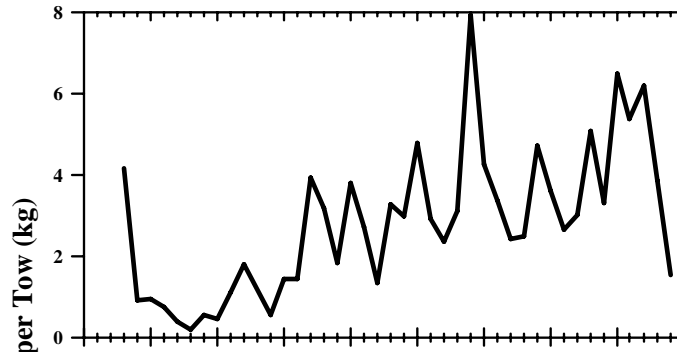


Figure 17. NEFSC autumn bottom trawl survey biomass indices for northern red hake.

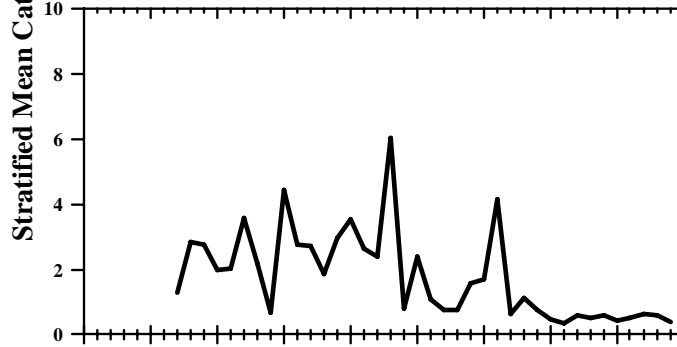


Figure 18. NEFSC autumn bottom trawl survey biomass indices for southern red hake.

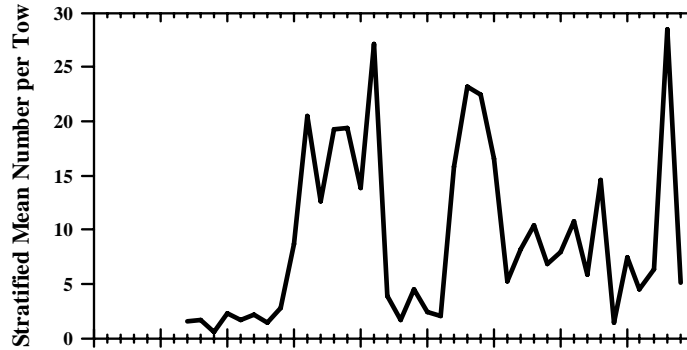


Figure 19. NEFSC autumn bottom trawl survey abundance indices for *Illlex*.

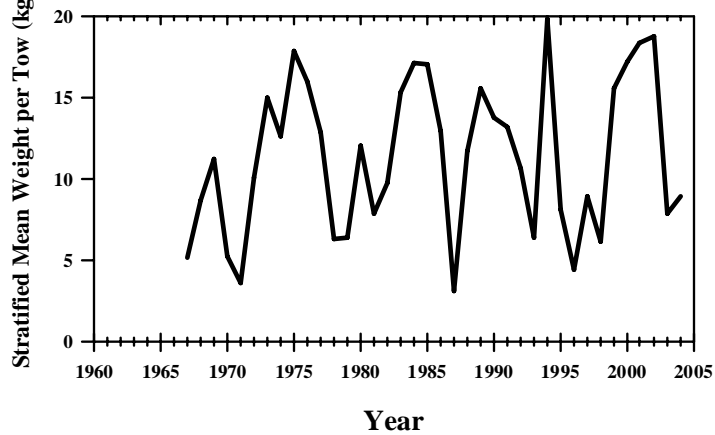


Figure 20. NEFSC autumn bottom trawl survey biomass indices for *Loligo*.

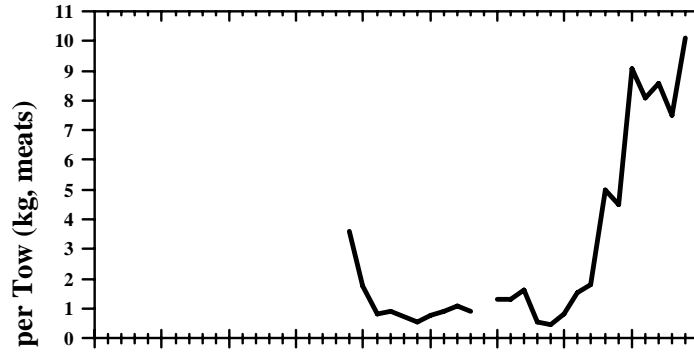


Figure 21. NEFSC scallop survey biomass indices for Georges Bank sea scallops.

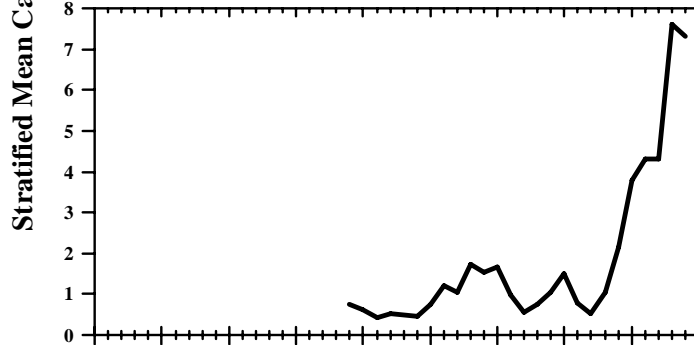


Figure 22. NEFSC scallop survey biomass indices for Mid-Atlantic Bight sea scallops.

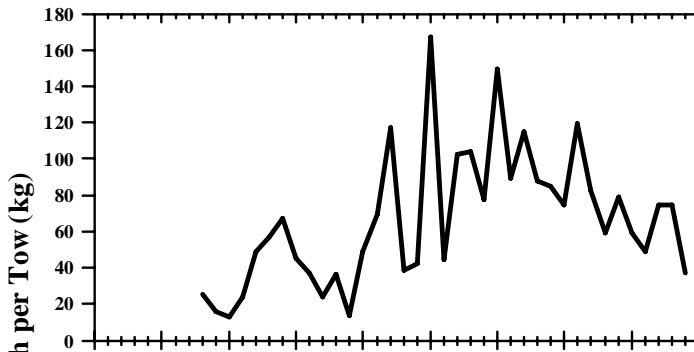


Figure 23. NEFSC spring survey biomass indices for spiny dogfish.

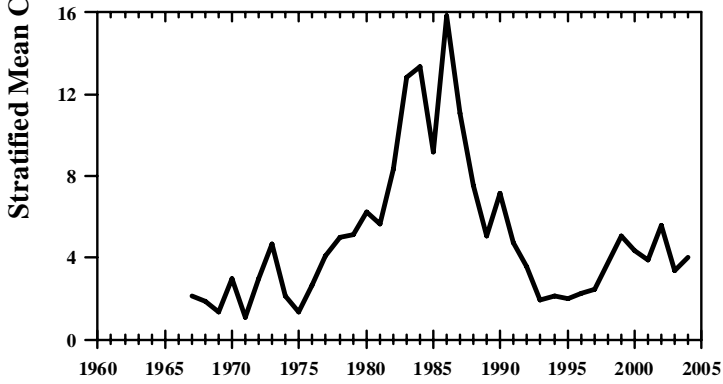


Figure 24. NEFSC autumn survey biomass indices for winter skate.

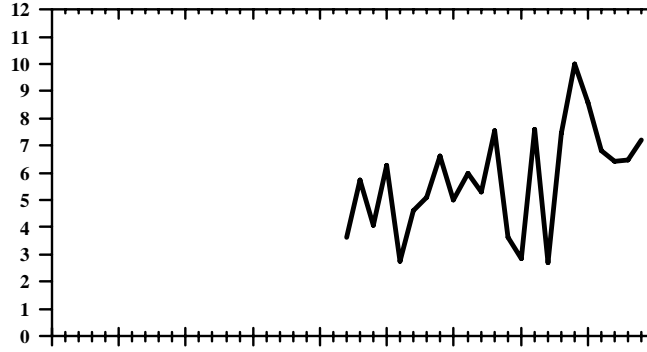


Figure 25. NEFSC spring survey biomass indices for little skate.

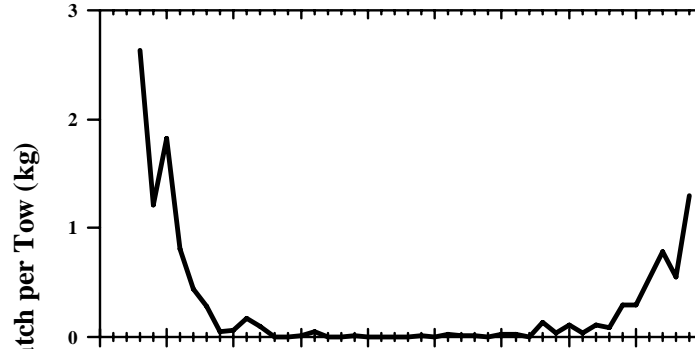


Figure 26. NEFSC autumn survey biomass indices for barndoor skate.

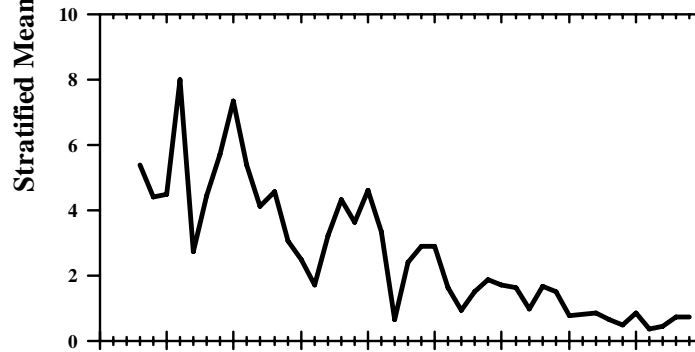


Figure 27. NEFSC autumn survey biomass indices for thorny skate.

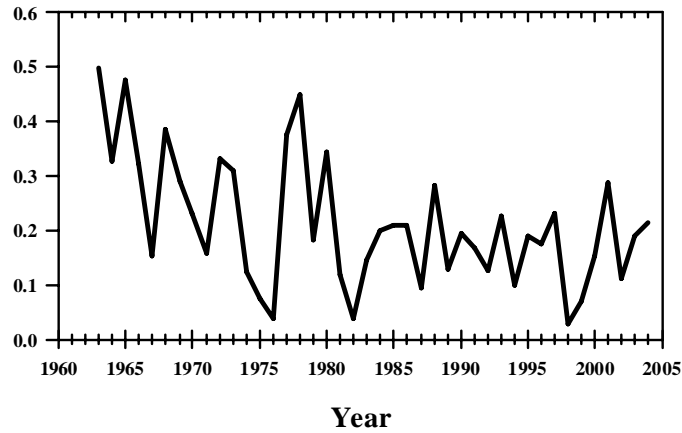


Figure 28. NEFSC autumn survey biomass indices for smooth skate.

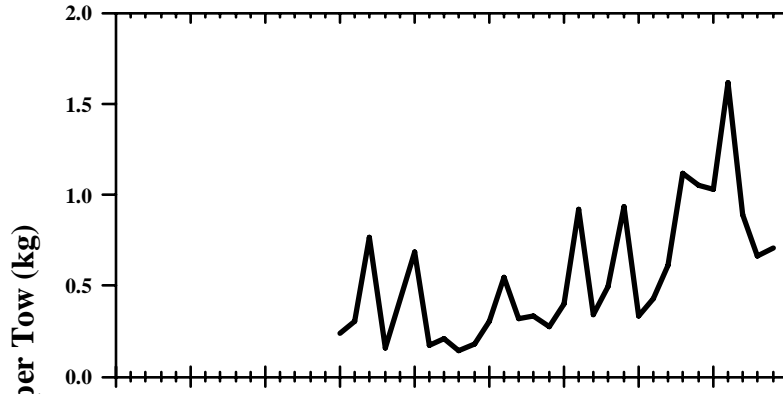


Figure 29. NEFSC autumn survey biomass indices for clearnose skate.

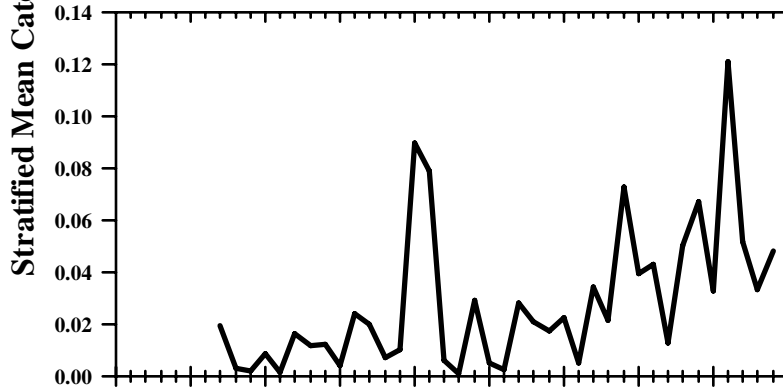


Figure 30. NEFSC autumn survey biomass indices for rosette skate.