Northwest Atlantic



Fisheries Organization

NAFO SCS Doc. 11/08

SCIENTIFIC COUNCIL MEETING – JUNE 2011

United States Research Report for 2010

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 off the northeastern coast of the United Statescan 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 been 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.

Some spring and autumn survey indices for 2009-2010 were converted from the FSV *Henry B. Bigelow* catches (weights) to RV *Albatross IV* catches (weights) using a single conversion factor for each species. Length specific conversion factors may be more appropriate, but these have only been estimated for some species. Consequently, 2009-2010 data points should be interpreted cautiously and these values may change in the future as new methodologies are considered. The 2009-2010 data points have been plotted separately in each of the figures presenting spring and fall survey data.

1. Atlantic Cod

USA commercial landings of Atlantic cod (*Gadus morhua*) from Subareas 5&6 in 2010 were 8,044 mt, a 10% decrease from 2009 landings of 8,952 mt and an 8% decrease from 2008 landings of 8,699 mt.

USA cod landings from the Gulf of Maine (Div. 5Y) in 2010 were 5,356 mt compared to 5,953 mt in 2009. Northeast Fisheries Science Center (NEFSC) research vessel survey biomass indices in the Gulf of Maine gradually increased through 2001 following the 1993 record low. The sharp increase in the autumn 2002 index cannot be explained by the dynamics of the stock, and was largely driven by an extremely large catch at one station. Since 2000, the autumn survey biomass index has remained slightly above the low values of the 1990s (Figure 1).

USA cod landings from Georges Bank (Div. 5Z and SA 6) in 2010 were 2,688 mt compared to 2,999 mt in 2009. The NEFSC research vessel survey biomass indices for the Georges Bank stock have remained at low levels during 1991-2010, with the exception of an increase in the 2002 index, due primarily to a large catch at one station, and an increase in the 2004 index as a result of three large tows in three separate strata. The 2010 autumn index decreased to 3.0 kg/tow from the 2009 value of 5.14 kg/tow but remains below the long term average (Figure 2).

2. Haddock

United States commercial landings of haddock (*Melanogrammus aeglefinus*) increased 68% from 5,835 mt in 2009 to 9,803 mt in 2010. Landings for Georges Bank (Div. 5Z) haddock increased from 5,335 mt in

2009 to 9,180 mt in 2010. Gulf of Maine (Div. 5Y) haddock landings increased from 500 mt in 2009 to 623 mt in 2010.

The autumn research vessel survey biomass indices for the Gulf of Maine stock increased in 2010 to 3.5 kg/tow relative to the 2009 estimate of 2.0 kg/tow (Figure 3). Gulf of Maine stock biomass has decreased from a recent high in 2000 as the strong 1998 year class has experienced both natural and fishing mortality. Recent estimates of autumn survey biomass for Georges Bank haddock peaked at 55.8 kg/tow in 2004. Since 2004 large fluctuations have occurred in the survey index. Mean biomass per tow was 34.2 kg/tow in 2009 and declined to 19.9 kg/tow in 2010 (Figure 4).

3. <u>Redfish</u>

USA landings of Acadian redfish (*Sebastes fasciatus*) increased by 13% from 1,461 mt in 2009 to 1,644 mt in 2010. Fall research vessel survey biomass indices have increased since 1996 (Figure 5) and the 2010 index is the highest on record. The consistently high biomass indices reflect the stock rebuilding that has occurred because of very low fishing pressure.

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

USA landings of pollock (*Pollachius virens*) decreased 31% from 7,436 mt in 2009 to 5,097 mt in 2010. Research vessel survey indices have reflected a moderate increase in pollock biomass in Subarea 5 from the mid-1990s through 2005 (Figure 6). In 2006, 2007 and 2008, however, the fall biomass indices declined sharply, to values last observed in the late 1990s. The biomass index for 2009 is the lowest observed in the time series, but the index increased to 3.1 kg/tow in 2010. The 2009 and 2010 indices are not expressed in Albatross IV equivalents because too few pollock were captured in the calibration experiments to derive reliable calibration coefficients for this stock.

5. White Hake

USA landings of white hake (*Urophycis tenuis*) increased by 7% from 1,697 mt in 2009 to 1,808 mt in 2010. Research vessel survey indices declined during the 1990s and increased in 2000 and 2001 due to good recruitment of the 1998 year class. The indices have been variable since 2001 (Figure 7).

6. <u>Yellowtail Flounder</u>

USA landings of yellowtail flounder (*Limanda ferruginea*) decreased by 19% from 1,615 mt in 2009 to 1,313 mt in 2010. Research survey biomass indices in 2010 also suggest that both Cape Cod-Gulf of Maine stock (Div. 5Y, N of Georges Bank) and Georges Bank (Div. 5Z, E of 69W) stocks declined in 2010, but to a lesser extent for the Cape Cod-Gulf of Maine stock. However, the Southern New England-Mid Atlantic index increased in 2010. In the Cape Cod-Gulf of Maine stock, survey biomass indices decreased by 38% from 6.0 kg/tow in 2009 to 3.7 kg/tow in 2010. On Georges Bank, the survey biomass index decreased by 66% from 6.5 kg/tow in 2009 to 2.2 kg/tow in 2010. In Southern New England-Mid Atlantic, the survey biomass index in 2010 increased to 3.7 kg/tow (Figures 8-10).

7. Other Flounders

USA commercial landings of flounders (other than yellowtail flounder) from Subareas 3-6 in 2010 totaled 9,700 mt, 1% higher than in 2009. Summer flounder (*Paralichthys dentatus*) (61%), winter flounder (*Pseudopleuronectes americanus*) (16% comprising the Georges Bank, Southern New England and Gulf of Maine stocks), American plaice (*Hippoglossoides platessoides*) (14%), witch flounder (*Glyptocephalus cynoglossus*) (8%), and windowpane flounder (*Scophthalmus aquosus*) (1% comprising the Northern and Southern stocks) accounted for virtually all of the 'other flounder' landings in 2010. Compared to 2009, commercial landings in 2010 were higher for summer flounder (19%) and American plaice (1%) but lower for windowpane flounder (-33%), winter flounder (-29%), and witch flounder (-20%). Research vessel survey indices in 2010 were stable for American plaice, increased for summer flounder, and decreased for

witch flounder, Georges Bank winter flounder, and northern windowpane flounder (Figures 11-15).

8. <u>Atlantic halibut</u>

USA landings of Atlantic halibut (*Hippoglossus hippoglossus*) in the Gulf of Maine-Georges Bank region decreased 56% from 45 mt in 2009 to 20 mt in 2010. Research vessel survey indices exhibit little trend and high inter-annual variability due to the low capture rates of Atlantic halibut. In some years, no Atlantic halibut have been caught, indicating that stock abundance is near, or below, the detectability level of the survey (Figure 16).

9. Silver hake

USA landings of silver hake (*Merluccius bilinearis*) increased by 4% from 7,762 mt in 2009 to 8,079 mt in 2010. Research vessel survey biomass indices for the Gulf of Maine - Northern Georges Bank stock varied without trend between 1985 and 1997, sharply increased in 1998, and then declined through 2005. Subsequently, the indices have increased and in 2010, the index was 13.4 kg/tow, the highest value since the mid-1990s. Survey biomass indices for the Southern Georges Bank - Mid-Atlantic stock have increased since 2007 and the 2010 survey biomass index (2.8 kg/tow) was the highest since the early 1980s (Figure 17-18).

10. Red Hake

USA landings of red hake (*Urophycis chuss*) remained stable at 613 mt in 2009 and 603 mt in 2010. Total landings have been low since 1980. USA nominal landings of the Gulf of Maine - Northern Georges Bank stock of red hake increased 50% from 34 mt in 2009 to 51 mt in 2010. Nominal landings of the Southern Georges Bank - Mid-Atlantic stock decreased 5% from 579 mt in 2009 to 553 mt in 2010. Research vessel survey biomass indices for the Gulf of Maine - Northern Georges Bank stock increased after the early 1970s, markedly declined from 2002-2003, and have since stabilized (Figure 19). Indices for the Southern Georges Bank - Mid-Atlantic stock declined in the 1980s, remained low through 2006 (Figure 20), but have since increased slightly.

11. Atlantic Herring

Total USA landings of Atlantic herring (*Clupea harengus*) decreased 34% from 103,942 mt in 2009 to 68,428 mt in 2010. Spring survey indices were relatively stable during 2002-2009 and averaged 2.4 kg/tow (Figure 21). The 2010 spring survey index was 1.9 kg/tow. Spawning biomass increased from 1982 to 1997 and has remained stable since 1998. SSB was estimated to be 515,600 mt in 2008. Recent assessments, however, have exhibited a strong retrospective pattern.

12. Atlantic Mackerel

USA commercial landings of Atlantic mackerel (*Scomber scombrus*) decreased 56% from 22,634 mt in 2009 to 9,877 mt in 2010. Recreational catches increased 4% from 747 mt in 2009 to 779 mt in 2010. Spring survey indices increased during the 1990s and averaged 9.8 kg/tow during 2001-2009. The spring survey index decreased from 13.9 kg/tow in 2009 to 6.5 kg/tow in 2010 (Figure 22). Results of an assessment of Atlantic mackerel were reviewed in 2010 by the Transboundary (US and Canada) Resources Assessment Committee (TRAC). The TRAC concluded that the abundance estimates were too uncertain for management purposes but that relative trends in F and SSB were informative.

13. Butterfish

USA landings of butterfish (*Peprilus triacanthus*) increased 32% from 435 mt in 2009 to 576 mt in 2010. Fall research vessel survey biomass indices have fluctuated substantially since the 1970s, but were generally highest in the late 1970s and early 1980s. Since 1995, annual values have generally been below than the long-term average (Figure 23).

14. Squids

Since 2005, USA landings of longfin inshore squid (*Doryteuthis (Amerigo) pealeii*, formerly *Loligo pealeii*) have been declining and totaled 6,716 mt during 2010, 28% lower than in 2009 (9,307 mt). The autumn survey abundance index declined from a near record high in 2006 (1,727 squid per tow) to 708 squid per tow in 2010 (Figure 24).

USA landings of northern shortfin squid (*Illex illecebrosus*) in 2010 totaled 15,825 mt, 14% lower than in 2009 (18,418 mt). The autumn survey abundance index attained a record high in 2006 (29.5 squid per tow), but declined to 10 squid per tow during 2008-2010 (Figure 25).

15. Sea Scallops

USA sea scallop (*Placopecten magellanicus*) landings in 2010 were 25,898 mt (meats), slightly less than 2009, but over twice the long-term (1957-2009) mean. The ex-vessel value of the landings was nearly \$450 million, the highest on record and an increase of \$76 million over 2009. About 23% of the 2009 landings were harvested from Georges Bank, whereas 76% were from the Mid-Atlantic Bight; the remainder was taken in Southern New England and the Gulf of Maine. Since 2000, a majority of the landings have come from the Mid-Atlantic region in every year except 2006. By contrast, during 1957-1999, most USA sea scallop landings were harvested from Georges Bank.

Stratified mean research vessel survey biomass increased slightly for Georges Bank but decreased substantially in the Mid-Atlantic in 2010; these indices remained high by historical standards (Figures 26 and 27). Recruitment was above average on Georges Bank but below average in the Mid-Atlantic. Georges Bank recruitment during 2008-2010 was the strongest observed in a decade.

16. Northern Shrimp

USA commercial landings of Northern shrimp (*Pandalus borealis*) from Subarea 5 in 2010 were 5,617 mt, a 76% increase from the 2005-2009 annual average of 3,195 mt but 56% lower than the record-high 12,824 mt landed in 1969.

The joint state-federal summer research vessel (R/V *Gloria Michelle*) survey biomass indices declined during 1985 through 2004. A sharp increase occurred in 2006; however, the survey in this year was considered less reliable due, in part, to a reduced number of tows. Biomass indices subsequently have declined, although the 2010 index is still above the 1985-2005 average (Figure 28).

17. Small Elasmobranchs

USA landings of spiny dogfish (*Squalus acanthias*) increased 1% from 5,392 mt in 2009 to 5,440 mt in 2009. Survey indices, which are highly variable, generally declined between the early 1990s and 2005 but increased sharply in 2006 and have since remained high (Figure 29).

USA landings of skates (most species still landed as unclassified) decreased by 2% between 2009 and 2010 from 18,243 mt to 17,799 mt. The landings are sold as wings for human consumption and as bait for the lobster fishery. Survey biomass indices for winter skate (*Leucoraja ocellata*) peaked in the mid-1980s (Figure 30) but then declined, possibly due to an increase in the directed fishery in the late 1980s and early1990s. During the mid-1990s, the indices stabilized at an intermediate level, but have increased in recent years. Little skate (*Leucoraja erinacea*) survey indices have generally fluctuated without trend until 2010(Figure 31). Survey indices for barndoor skate (*Dipturus laevis*) declined precipitously in the mid-1960s, remained very low through the late-1980s, and subsequently increased to levels observed in the mid-1960s (Figure 32). Thorny skate (*Amblyraja radiata*) survey indices for smooth skate (*Malacoraja senta*) are highly variable, but have been generally stable for the last 20 years (Figure 34). Indices for both clearnose skate (*Raja eglanteria*) and rosette skate (*Leucoraja garmani*) generally increased over the time series (Figures 35 and 36). The indices for clearnose skate declined between 2001 and 2006, but sharply increased in both 2007 and 2008.

B. Special Research Studies

1. Environmental Studies

a) <u>Hydrographic Studies</u>

A total of 1776 CTD (conductivity, temperature, depth) profiles were collected and processed on Northeast Fisheries Science Center (NEFSC) cruises during 2010. Of these 1753 were obtained in NAFO Subareas 4, 5, and 6. These data are archived in an oracle database. Cruise reports, annual hydrographic summaries, and data are accessible at:

<u>http://www.nefsc.noaa.gov/epd/ocean/MainPage/index.html</u>. CTD data from 5 cruises in 2010 remain to be processed. When these data are processed, they will be added to the oracle database and cruise reports will be accessible at the same website.

b) Plankton Studies

During 2010, zooplankton community distribution and abundance were monitored on six surveys using 699 bongo net tows. Each survey covered all or part of the continental shelf from Cape Hatteras northward, up through the Mid-Atlantic Bight, across Southern New England waters and Georges Bank, and the Gulf of Maine. The Ship of Opportunity Program (SOOP) completed 13 transects across the Gulf of Maine from Cape Sable, NS to Boston, and 13 transects across the Mid-Atlantic Bight from New York to the Gulf Cruise available Stream. reports and data are from the website: http://www.nefsc.noaa.gov/epd/ocean/MainPage/ .

c) Benthic Studies

The NEFSC's James J. Howard and Woods Hole Laboratories, U. S. Geological Service (USGS), and several collaborating academic institutions continued to conduct field programs to develop methods for mapping, characterizing, and developing hypotheses regarding benthic habitats and their macrobenthic and demersal communities during 2010. Several planned programs, however, were severely curtailed by redeployment of vessels and personnel to address the Deepwater Horizon crisis in the Gulf of Mexico.

A 9 day cruise was conducted during January, 2010 to train students in the NOAA Living Marine Resources Cooperative Science Center (LMRCSC) program, and to conduct joint research projects with NMFS and LMRCSC faculty from the University of Maryland Eastern Shore. Scientific findings included the following:

- A pattern is emerging on the Hudson Canyon shelf and slope in which a background of resident species appear consistently in particular habitats year-to-year while others, largely seasonal migrants, do not appear to make use of those habitats in a consistent manner, even in the same season. Data from this and other cruises are being assembled into a habitat model to better understand the factors governing the distribution of resources around this canyon.
- Dense patches of deepwater corals (the solitary cup coral *Dasmosmilia lymani*) and sponges continue to persist around the rim of Hudson Canyon. This distribution information is currently being incorporated into habitat suitability models and habitat maps for the Canyon.
- Juvenile black sea bass (*Centropristis striata*) habitat were again encountered in the gravelly rim of Hudson Canyon
- Methods continued to be developed to assess year-to-year changes in biota based on a combination of samples taken on a grid of fixed, geographically widespread sites along the mid-Atlantic shelf (the Latitudinal Transects). These efforts will lead to a near-synoptic assessment of hydrological factors that affect migratory patterns. Subject to further development and critical review, this work could serve as a direct biological indicator of fisheries ecosystem state.
- For the third consecutive year (2008, 2009, 2010), substantial numbers of juvenile southern white shrimp (*Litopenaeus setiferus*) were taken on the shelf off Virginia. The distribution of this species should be monitored as a possible indicator of climate change.

- Monkfish (*Lophius americanus*) were caught at depths ranging from 59 to 643 m, and in larger numbers (153) than on previous LMRCSC cruises. Large trawl catches in deep water were associated with substantial catches of sessile anemones, suggesting association with hard bottom. The largest trawl catch occurred in an area of uneven, presumably sandy, bottom thought to be the result of Pleistocene iceberg scouring. This is not the first time that monkfish have been caught in this area. Individuals >50 cm total length were found largely in Hudson Canyon; Norfolk Canyon catches consisted almost entirely of smaller individuals.
- High densities of deep-sea red crab (*Chaceon quinquidens*) and witch flounder (*Glyptocephalus cynoglossus*) were estimated from catches in both the Norfolk and Hudson Canyon areas. All deep water trawl catches were dominated by these two species. The highest abundance of red crabs occurred between 500 m and 700 m, beyond the depth range of NEFSC survey trawls. As in 2009, adult-sized witch flounder were more common in Hudson Canyon than in Norfolk Canyon.
- Several species of deep water crustaceans were caught, including royal red shrimp (*Pleoticus robustus*).

A 6-day cruise was conducted during late October along the northern edge of Georges Bank to explore fisheries resource species associations with bottom habitats. Video and still photo images were gathered using the USGS Seaboss drift vehicle. A series of CTD hydrographic transects was also conducted to better understand the role of tidal hydrology in structuring bottom habitats and fish communities.

- Hydrographic transects revealed that the strong tidal pattern of bottom water temperature fluctuations observed during the summer persists into the fall. Up to 3° C total change was recorded between high and low tides. As in summer, this change lessens with distance from the Bank-Slope break, gradually terminating in constant warm bottom temperatures in a vertically mixed water column ~15 km south of the break. The extent of tidal temperature fluctuation in the fall is smaller (3° versus 6° C), and the zone of influence narrower (15 km versus 20 km), than during the summer.
- Measurements of chlorophyll fluorescence along sampling transects revealed a three-fold fluctuation in phytoplankton abundance associated with tidal temperature changes. Warmer, high chlorophyll water from Georges Bank dominated the frontal zone during high tide, while colder, low chlorophyll water from the Gulf of Maine dominated during low tide. This fluctuating pattern has strong implications for benthic trophic production, and for benthic and demersal stock habitat values.
- Limited Seaboss camera vehicle observations indicated very heavy coverage by the invasive tunicate *Didemnum vexillum* on hard substrates on the crest of Georges Bank south of 42°00' N, where it had been previously reported. There was no indication of a hypothesized fall die-back, and no new northward range extension into the tidally-varying frontal zone.

We were unable to conduct a cruise in August 2010 to investigate benthic and pelagic habitat conditions in Hudson Canvon, off New Jersey. However, considerable progress was made by faculty and students at the University of Mississippi in creating ultra-high resolution maps of Hudson Canyon based upon multibeam sonar data collected in 2007, 2008, and 2009. Horizontal resolution – approaching 2 m at all depths in the 90 to 800 m depth range – was made possible by mapping with a multibeam system aboard an autonomous underwater vehicle (AUV) flown at a constant 50 m from the bottom. Work in 2010 expanded the area of post-processed maps to include about two-thirds of the portion of the Canyon that cuts into the continental shelf. A larger extent of previously unknown features was revealed. This included: (a) steep, high backscatter cliffs that resemble those known to support deep water soft coral communities in New England; (b) crater-like depressions that probably represent regions of methane release from buried gas hydrate deposits; and (c) linear high-backscatter pockmarks having substantial microbial chemosynthesis (probably methane-based) that may support deep water epifaunal communities. Previously defined features whose boundaries were more clearly and sharply defined in 2010 included outcrops of semi-lithified clay in canyon walls, and hummocky microtopography thought to be created by persistent burrowing by golden tilefish (Lopholatilus chamaeleonticeps). Strong differences were identified in the morphology (and possible geological activity) of the eastern and western walls of the Hudson Canyon. Features indicating strong bottom currents (e.g., sand waves, scour channels) were also documented. In 2011, these mapping results will be combined with the results of bottom photo transects and trawl catches to produce fisheries habitat models and a habitat classification scheme for Hudson Canyon.

2. Biological Studies

a) Fish Species

<u>Flatfishes:</u> The relative roles of (a) the environment and (b) parentage in influencing offspring quality and viability in winter flounder, *Pseudopleuronectes americanus*, are now being analyzed from an experimental study. Such information is important in understanding recruitment patterns and in evaluating the aquacultural potential of this species. The experimental study was designed to evaluate the relative contributions of paternal, maternal, and thermal contributions to early life-history traits of winter flounder offspring. Preliminary data analyses show the relative ranking of families (sib-groups) with respect to their ability to alter their growth and developmental rates in response to environmental changes. In winter 2010-11, a study of winter flounder growth morphometrics and condition was initiated in which flounder are being reared at three temperatures and under various feeding regimes to generate variability in size, shape, and condition. The effects of temperatures on these measures of performance, and the inter-relationships among them, will be quantified. Relationships between maternal attributes (age, size) and offspring quality (attributes of eggs, embryos, larvae, and young juveniles) are also being studied in summer flounder, *Paralichthys dentatus*. This work is being conducted in cooperation with other federal and academic scientists in the USA mid-Atlantic region.

Gadids: Field and laboratory research continues on Atlantic tomcod, Microgadus tomcod, a locally abundant inshore gadid of the Northeastern USA and Eastern Canada. Tomcod have a 1-yr life cycle, are an important forage species, 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. In 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. In the toxicological theme, three source populations – Hudson River, Shinnecock Bay (Long Island, New York) and Miramichi River (New Brunswick, Canada) – that differ in contaminant histories are being compared with respect to: (1) uptake and depuration rates of dioxin and locally occurring (Hudson River) congeners of PCBs; (2) sublethal toxic responses to graded doses of local PCBs congeners using captive (F_1 and F_2) tomcod populations; and (3) interactions between environmental stressors, such as PCBs and high summer temperatures. The toxicological work in 2009-10 included an assessment of the combined effects of PAHs and PCBs on ecologically relevant toxic endpoints, and estimates of toxicities of individual congeners (PCB 77, 81, 126, and 169). We recently completed the 13 month grow-out period, and sacrificed the adult fish to obtain body/gonad/liver samples for histological and biochemical analyses so that these results can be related to exposure history. We also continued an assessment of effects of nanoparticles on tomcod early life-stages to assess the effects of type and dose of commonly manufactured nanoparticles on this species.

<u>Sturgeons</u>: Several pilot eco-toxicological studies were conducted in 2009-10 on shortnose and Atlantic sturgeons (*Acipenser brevirostrum* and *A. oxyrhynchus*, respectively). Toxic responses of eggs and larvae to aqueous exposures to PCB 126 and TCDD are being evaluated. Rates of uptake of radio-labelled PCB126 are also being quantified. Responses evaluated to date include viability, macro-phenotypic characters (e.g., days to hatch, morphometrics of recently hatched larvae, and starvation resistance), and molecular effects (CYP1A1). Uptake was found to be a linear function of exposure doses, and toxicity was expressed in both species to both contaminants in lethal and sublethal responses. In 2010, we conducted preliminary evaluations of the toxicities to shortnose sturgeon of individual congeners and Aroclor mixtures.

<u>Hudson River Estuary Ecosystem</u>: Field and laboratory evaluations of abundance patterns of ichthyofauna in the Hudson River Estuary Ecosystem, and the processes affecting these patterns, continued in 2010. Regular (monthly) sampling of the estuary during April through October has been conducted since 1999. These data, along with data from earlier federal projects and from ongoing surveys by state and private concerns, are being analyzed for community-wide patterns and for associations between target species and habitat variables. Trends in recruitment of Atlantic tomcod are also being studied. Two 1000 hectare seascapes south and west of the mouth of the Hudson River estuary were designated by personnel from the Behavioral Ecology Branch, Ecosystems Processes Division, NEFSC in 2008. Both seascapes possess similar benthic habitats, but the pelagic habitats differ substantially due to current flow. Based on 2008 and 2009 bottom trawl, underwater video survey, and ichthyoplankton samples, it was determined that oceanographic factors result in different sources of larvae (and thus different community structures) in the two seascapes. In 2010, an adaptive ichthyoplankton sampling was initiated, based on IOOS ocean imagery (HF radar, satellite) and shipboard hydro-acoustic and CTD measurements. It is hypothesized that oceanographic fronts, which are 3-dimensional dynamic structures of the coastal pelagic environment, influence the species/size composition of the ichthyoplankton communities in the two seascape areas. A second year of adaptive ichthyoplankton sampling is planned for 2011.

b) <u>Resource Survey Cruises</u>

During 2010, personnel from the Ecosystems Surveys Branch (ESB) staged, staffed, and supported the spring and fall multispecies bottom trawl surveys and the northern shrimp trawl survey. Additional staff and gear support was provided for the sea scallop dredge survey and the Atlantic herring hydroacoustic survey for a total of 204 research and charter vessel sea days. NOAA scientific and contract staff participation on these cruises totaled 1826 staff sea days, and volunteers contributed another 636 person sea days. ESB cruises occupied 1449 stations in an area extending from Cape Hatteras, North Carolina to Nova Scotia including the Gulf of Maine. A total of 2,444,679 length measurements were taken from 310 species during these cruises. Ecosystem survey data currently are used as fishery independent abundance or biomass inputs in 48 single species stock assessments, and have also been used in several ecosystem dynamics modeling efforts.

Sampling requests from 37 NOAA and University investigators were fulfilled during the various surveys conducted in 2010. These included 22,384 feeding ecology observations, 31,500 aging structures removed, and 20,214 samples or individual specimens collected to support additional shore based research.

c) Age and Growth

Approximately 67,000 age determinations for 12 species of finfish were completed in 2010 by Woods Hole Laboratory staff in support of resource assessment analyses. In addition to aging Atlantic cod (6,885), haddock (5,932), and yellowtail flounder (7,784), large numbers of pollock (13,078), silver hake (9,847), and summer flounder (9,234) were also aged. Age determinations for Atlantic herring, Atlantic mackerel, American plaice, goosefish, scup, and winter flounder totaled 14,609.

Haddock and pollock age structures were exchanged with age readers from the St. Andrews Biological Station (Fisheries and Oceans Canada) to maintain comparability of age determinations between laboratories. A pollock aging workshop was also convened in July 2010 to discuss the results of the exchange. Internal efforts to monitor and maintain accuracy and precision in age determinations have continued, and are available on the Fishery Biology Program website.

Research projects which continued in 2010 included: (1) enhanced biological sampling of three species of flatfish to examine monthly aspects of diet, reproductive biology, and condition; (2) histological sampling to calibrate macroscopic gonad staging performed during research vessel survey cruises; (3) a validation study of scale and otolith aging methods for American shad; (4) analysis of results from an experimental study examining reproductive biology and condition of black sea bass at varying ration levels; (5) analysis of environmental effects on haddock growth; (6) an age validation study of Atlantic surfclams using sectioned chondrophores obtained from samples collected across the geographic range of the species; and (7) a study investigating the feasibility of measuring bioelectrical impedance (BIA) as a predictor of fish condition and reproductive potential.

New projects initiated in 2010 included: (1) a reproductive study of maturation, sex change, and reproductive seasonality of the migratory black sea bass population from the mid-Atlantic states and southern New England; (2) an initiative to age summer flounder by sex from samples collected in both the recreational and commercial fleets; and (3) a mark-recapture study on spiny dogfish to validate an aging method using vertebrae.

d) Food Web Dynamics

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

Food habits samples were collected on the northeastern and Mid-Atlantic continental shelf during NEFSC spring and autumn surveys. Estimates of prey volume and composition were made at sea for selected species. During the 2010 spring and autumn surveys, 10,392 stomachs from 55 species, and 7,274 stomachs from 58 species were examined respectively. Diet sampling emphasized gadiformes, elasmobranchs, small pelagics, flatfishes, and lesser known species.

The 38 year time series (1973-2010) 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 550,000 stomach samples. The processing of the 2010 bottom trawl survey food habits data is scheduled for completion in 2011.

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

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 in 2010 to tag large coastal and pelagic sharks and provide information to define essential fish habitat for shark species in US waters. Information was received on 3,800 tagged and 270 recaptured fish, bringing the total number tagged to 220,000 sharks of more than 50 species and 13,100 sharks recaptured of 33 species.

Pelagic shark biology, movements, and abundance studies continued in 2010 with further investigations of pelagic nursery grounds in conjunction with the high seas commercial longline fleet. This collaborative work offers a unique opportunity to sample and tag blue sharks and shortfin makos in a potential nursery area and to collect length-frequency data, biological samples, and conduct conventional and electronic tagging of these species. Thus far, over 2,500 sharks have been tagged and 151 have been recaptured. Most of the recaptures are blue sharks (114) recovered by mid-Atlantic commercial fishermen. In addition, 250 blue sharks were double tagged using two different tag types to help evaluate tag-shedding rates used in sensitivity analyses for population estimates, and to estimate blue shark fishing mortality and movement rates. A total of 500 sharks have now been double tagged.

A study of shark predation on five species of seals on Sable Island, Nova Scotia, Canada, was published in the Proceedings of the Nova Scotian Institute of Science. Flesh wound patterns, tooth fragments, and bone markings were used to determine that Greenland sharks are the principal predator of seals on Sable Island. This work was completed with Sable Island researcher Zoe Lucas.

The NEFSC Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) survey continued to investigate known and putative shark nursery areas along the US east coast to identify species composition and habitat preferences, and also to determine the relative abundance, distribution and migration of sharks through longline and gillnet sampling and mark-recapture data. In 2010, other COASTSPAN participants included the Massachusetts Division of Marine Fisheries (MDMF), the North Carolina Division of Marine Fisheries, the South Carolina Department of Natural Resources, the Georgia Department of Natural Resources, and the University of North Florida. NEFSC staff conduct the survey in Narragansett and Delaware Bays. NEFSC and MDMF staffs also conduct a survey in the U.S. Virgin Islands using COASTSPAN gear and methods. Habitat utilization and essential fish habitat studies of juvenile sand tigers progressed using satellite telemetry in Rhode

Island waters, and satellite and passive acoustic telemetry in Massachusetts waters. These studies were partially funded by a grant from the 2010 NMFS Species of Concern Internal Grant Program.

NEFSC staff recently recovered shark species catch per set data from the exploratory shark longline surveys conducted by the Sandy Hook and Narragansett Laboratories from 1961 to 1991. This recovery is part of a larger project to electronically recover and archive: (a) historical longline survey data; and (b) biological observations of large marine predators (swordfish, sharks, tunas, and billfishes) in the North Atlantic. Standardized indices of abundance from the survey time series for dusky and sandbar sharks were created using a delta-lognormal generalized linear model for use in the 2010 Southeast Data, Assessment, and Review (SEDAR) Data Workshop. Work is ongoing to further refine these indices and to develop indices of abundance for use in future shark stock assessments and EFH designations.

Staff participated in the SEDAR Data Workshop for the assessments of blacknose, dusky and sandbar sharks. Seven working papers were prepared summarizing: (a) blacknose, dusky, and sandbar shark mark/recapture data from the Cooperative Shark Tagging Program; and (b) trends in relative abundance of blacknose, dusky and/or sandbar sharks in the COASTSPAN surveys in Georgia, South Carolina, and Delaware Bay, the NMFS northeast longline surveys, the NEFSC historical shark longline surveys, and the University of North Carolina shark longline survey.

f) Marine Mammals

In 2010, NEFSC began work on the Atlantic Marine Assessment Program for Protected Species (AMAPPS), which is a partnership with the Bureau of Ocean Energy Management, Regulation, and Enforcement and the US Fish and Wildlife. As part of this program, NMFS intends to conduct seasonal surveys of the Atlantic coast over the next several years. The goal of the program is to provide a better understanding of the distribution and abundance of sea turtle, marine mammal, and seabird populations, and to develop a decision-support tool for use in evaluating the likely impacts of various industrial, military, and development activities within U.S. Atlantic waters.

Small Cetaceans:

As part of the AMAPPS project, during August 17-September 26, 2010, the NEFSC conducted an aerial abundance survey targeting marine mammals and sea turtles using a chartered Twin Otter aircraft. The plane flew at an altitude of 600 feet and at a speed of about 110 knots. The survey covered waters from Long Island, New York to the mouth of the Gulf of St. Lawrence, Canada, and from the coast line to the 2,000-m depth contour. Circle-back (Hiby) data collection methods were used, where circles were performed on groups of cetaceans and turtles that had five or fewer animals per group. Within the study area of 325,072 km², there were about 9,210 km of on-effort track lines, of which 8,300 km were conducted in sea state conditions less than Beaufort 4. On these track lines, 15 cetacean species and 4 turtle species were detected. There were 99 circle-backs performed on 15 species/species groups. The data from the circle-backs will be used to estimate g(0) for these species, where g(0) is defined as probability of detecting a group on the trackline.

Incidental bycatches of cetacean, turtle, and seal species were estimated based on observed takes in commercial fisheries from Maine to North Carolina. Fisheries observed during 2010 included gill nets, otter trawls, mid-water otter trawls, mid-water pair trawls, scallop trawls, shrimp trawls, scallop dredges, clam dredges, purse seines, beach anchored gillnets, bottom longline, pound nets, and some pot and traps. Cetaceans observed taken included harbor porpoises (*Phocoena phocoena*), Risso's dolphins (*Grampus griseus*), common dolphins (*Delphinus delphis*), Atlantic white-sided dolphins (*Lagenorhynchus acutus*), and bottlenose dolphins (*Tursiops truncatus*). To support Atlantic Take Reduction Teams (e.g., harbor porpoise, coastal bottlenose dolphin, and Atlantic trawl teams), the observer data were investigated to identify environmental factors, fishing practices, or gear characteristics associated with the bycatches. The NEFSC has been working with the gillnet fishery to reduce harbor porpoise bycatch. In 2010 a study was completed that compared the effects of two gillnet configurations (hung at 0.5 versus hung at 0.33) on marine mammal interactions and catch retention of commercially important finish species (available at http://nefsc.noaa.gov/publications/reports/EA133F08CN0240.pdf). Additionally, a project on the

effectiveness of tie-downs in the bottom set gillnet fishery on the catch of sturgeons, marine mammals, and targeted catch was completed. The report for this project is currently under review.

Large Cetaceans:

The 2010 North Atlantic right whale survey DE10-03 was conducted from May 3 through May 21, 2010, aboard the NOAA ship Delaware II. The principal objectives of the cruise were to: study North Atlantic right whale dive behavior as it relates to prey distribution; obtain photographs for individual whale identifications; collect biopsy samples and acoustic recordings from large whales; and test new technologies that may allow scientists to survey large areas acoustically using autonomous gliders. Specific achievements included: (1) tagging large whales, primarily North Atlantic right whales (*Eubalaena glacialis*) and secondarily sei whales (*Balaenoptera borealis*), with suction-cup and dermal-attachment TDR (time-depth recorder) tags, tracking them, and sampling near the tagged whales with the CTD/OPC/VPR instrument package; (2) photographing and biopsy sampling of large cetaceans (mostly North Atlantic right whales) for individual identification; (3) conducting 'drifting anchor stations', where four drifting (RATS) buoys and two Apex profile floats were deployed near autonomous gliders; and (4) deploying zooplankton tows to collect data on the principal prey of North Atlantic right and sei whales. The area of operations was the Great South Channel, east of Cape Cod, Massachusetts, with most of the right whale work conducted between 41.5N to 41.8N and 69.3W to 69.6 W. Copepod tows were conducted in this general area, as well as to the east in Franklin's Basin.

The North Atlantic Right Whale Sighting Survey (NARWSS) is a NOAA Fisheries Service program that locates and records the seasonal distribution of North Atlantic right whales off the northeastern coast of the United States. NARWSS flights conducted in 2010 followed randomized systematic track lines within ten primary survey blocks: Cashes Ledge, Franklin Basin, Georges Basin, Georges Shoal, Great South Channel, Howell Swell, Jeffreys Ledge, Jordan Basin, Lindenkohl Basin, and Stellwagen Bank. An additional survey block was added this year in Rhode Island Sound. During 2010, there were 59 surveys totaling 280 flight hours, including assistance in several disentanglement operations, a modified sawtooth survey over the NOPP acoustic buoy array in the Stellwagen Bank National Marine Sanctuary, and a directed flight over autonomous gliders in the Great South Channel. There were 476 right whales detected within survey blocks, and an additional 32 right whales sighted during transits to or from survey areas. There were no surveys flown from June through September, as the aircraft was redirected to assist protected species surveys in the Gulf of Mexico following the Deepwater Horizon oil spill.

During January-March 2010, skin samples were collected from right whales on the calving grounds in the coastal region (<25 nmi from land) between Savannah, GA and St. Augustine, FL. Whales were located by aerial spotting teams, and skin and blubber samples were obtained using biopsy darts deployed by crew in an inflatable boat. DNA in right whale skin can be used to determine sex, and to create a genetic "fingerprint" for later re-identification. These samples will be added to the extensive collection of right whale DNA (obtained from approximately 300 individual right whales) maintained at Trent University in Ontario, Canada. DNA collected and archived through the project will not only help researchers identify individual whales and their paternity, but also to (1) assess genetic variation in the population; (2) determine how many females are reproductively active; (3) monitor the health of individual animals, and (4) better understand the right whale mating system.

Since 2007, and continuing through June 2010, the NEFSC has been involved in an ocean noise project in the Stellwagen Bank National Marine Sanctuary. The objectives of this project were to map the ocean noise budget within the sanctuary, characterize various contributing noise sources (biological and anthropogenic), and evaluate the noise impact, masking and shrinkage, in the communication area. Communication ranges for 89 right whales were modeled over the course of one month (April 2008) and indicated that 72-84% of the communication space has been lost to calling right whales under present-day conditions. Work on communication masking has now been expanded to multiple species and call types, integrating sound fields from multiple types of vessels.

NEFSC researchers have been working to: (a) elucidate the basic acoustic behavior of various species; (b) validate passive acoustic results with respect to other monitoring platforms; and (c) evaluate the

effectiveness of passive acoustics as a tool for both monitoring and mitigation. Part of the project focuses on the acoustic behavior of right whale mother-calf pairs. This research is being conducted in collaboration with Dr. Susan Parks (Penn. State University). Fieldwork in the Bay of Fundy, Cape Cod Bay, and on the Southeast calving grounds involves obtaining recordings using a towed hydrophone from a small boat. Another project is exploring variation in right whale calling activity. Patterns and behavioral ecology at different spatial and temporal scales are being analyzed. Researchers are finding high call rates for shorter bouts in the winter and lower call rates for longer bouts in the spring. Gunshot call activity peak in January, while upcalls are more predominant in spring. The occurrence and movement of singing humpback whales is also being examined. Movement patterns of humpbacks tracked acoustically are being compared in pre- and post-migration seasons. Anthropogenic impacts on singing humpbacks on the foraging grounds are also being studied. Decreases in singing activity have been detected in response to acoustic transmissions at distance of over 200 km.

An acoustic abundance estimation project is aimed at developing protocols for monitoring spatial and temporal trends in relative abundance, working towards absolute acoustic abundance estimates for cetaceans, and integrating acoustic abundance estimates with visual abundance estimates.

An autonomous acoustic technology project is underway using glider technology to (a) record low and midfrequency marine mammal vocalizations; (b) detect, classify and remotely report vocalizations of interest; and (c) collect oceanographic data. Three gliders were deployed in the Great South Channel in 2010, with transect locations selected based on encounter rates with baleen whales during previous shipboard surveys. Data from the gliders are now being analyzed.

Scarification analyses of right and humpback whales continued in 2010. These analyses are used to monitor interactions between whales and fishing gear.

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

Pinnipeds:

Aerial monitoring of major harbor seal and gray seal haul-out sites in southern Massachusetts continued in 2010. Major gray seal pupping colonies in Massachusetts and Maine coastal waters were also surveyed. Thirteen aerial seal surveys were conducted.

g) Turtles

The NEFSC collaborated with academics, industry groups, and researchers from other NMFS science centers to assess and to collect data on sea turtles in U.S. Mid-Atlantic waters and to reduce sea turtle bycatch in U.S. commercial fisheries in the Northwest Atlantic Ocean. In 2010, fishery-dependent research efforts focused on Mid-Atlantic bottom trawl fisheries and Mid-Atlantic sea scallop fisheries. Fishery independent research focused on sea turtle distribution and behavior in U.S. Mid-Atlantic shelf waters.

In 2010, the NEFSC undertook (or contracted) several gear and gear-related projects. These included: (1) a study of the effect on catch performance in the Southern New England longfin squid trawl fishery of the NMFS flounder Turtle Excluder Device (TED) equipped a large opening; (2) a study of catch retention of summer flounder in the summer flounder trawl fishery using a larger TED with a larger-sized opening; and (3) a sea scallop dredge comparison study to (i) ascertain the effectiveness of a modified dredge in lifting sea turtles over the dredge thereby reducing the potential for turtle injuries and (ii) evaluate the catch performance of this modified dredge; A two day workshop with the fishing industry was also held in 2010 to attain input regarding the research projects completed to date aimed at mitigating sea turtle bycatch in trawl fisheries, and to receive industry guidance on future research directions.

In 2010, the NEFSC supported work with ROVs to describe sea turtle behavior in areas frequented by sea scallop dredge fishing activities. The video data collected from the ROV yielded new information on sub-adult sea turtle behavior.

NEFSC conducted several bycatch analysis projects in 2010. In one project, the number of loggerhead and hard-shelled turtle species interactions with US mid-Atlantic scallop dredge gear was estimated before - and after - gear modifications were implemented in the fishery. This study also identified times and areas where interaction rates were high. In another project, loggerhead interactions were estimated in Mid-Atlantic bottom trawl fisheries for fish and scallops, including estimating the number of turtles that passed through turtle excluder devices. Both projects, reported the magnitude of adult-equivalent interactions, an important metric for understanding population level impacts of fisheries interactions.

As part of the AMAPPS, NMFS deployed satellite tags on wild-captured sea turtles to monitor movements and behavior, and to collect information on diving and surfacing times to develop correction factors for the proportion of turtles underwater during aerial surveys (and therefore not observed during these surveys). Fourteen satellite tags were deployed on immature loggerhead sea turtles collected in offshore Mid-Atlantic shelf waters. NMFS staff also derived an at-sea, coastal abundance estimate of loggerhead sea turtles based on the results of the 2010 aerial survey, which included a correction based on the satellite tag data (available at http://nefsc.noaa.gov/publications/crd/crd1103/).

h) Seabirds

The NEFSC published a manuscript on the bycatch of common loons and red-throated loons in Northeast and Mid-Atlantic gillnets based on analyses of observer data (available at <u>http://www.nmfs.noaa.gov/by_catch/docs/loon_paper.pdf</u>). NEFSC staff also conducted necropsies on bycaught seabirds recovered from observer fishing trips. During January 27-29, 2010, the NEFSC hosted the Northwest Atlantic Marine Bird Conservation Cooperative Workshop.

3. Studies of Fishing Operations

In 2010, NEFSC Observers were deployed on 2,792 trips aboard commercial fishing vessels. Kept and discarded catches were weighed, or estimated, on 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 181 marine mammal incidental takes, 5 sea turtle incidental takes, and 185 seabird incidental takes. For most of these takes, information was recorded on animal condition, length (and other relevant body measurements), and species identification characteristics. Tissue samples were also collected from many of these animals and, when possible, the entire animal was collected.

In addition, the Northeast Fisheries Observer Program (NEFOP) deployed At-Sea Monitors on 2,379 trips aboard commercial fishing vessels in 2010. On these trips, takes were documented of 216 marine mammals, seven sea turtles, and 479 seabirds.

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

In the sink anchored gillnet fishery, NEFSC Observers observed 739 trips comprising 3,142 gear retrievals . A total of 118 observed marine mammal takes occurred in this fishery (56 gray seals, 23 harbor porpoises, 21 harp seals, eight harp seals, five unidentified seals, three common dolphins, one whitesided dolphin and one pilot whale). There were also 131 observed seabird takes (118 of which were greater shearwater).

In 2010, At-Sea Monitors in the sink anchored gillnet fishery observed 1,449 trips comprising 4,987 gear retrievals. The observed takes included 161 marine mammals (60 gray seals, 55 harbor seals, 33 harbor porpoises, five whitesided dolphins, four unidentified seals, three common dolphins and one unidentified porpoise/dolphin), six sea turtles (five loggerhead turtles and one unidentified hard shell turtle) and 450 seabirds (411 of which were greater shearwaters).

b) <u>Float Drift Gillnet Fishery</u>

In 2010, 21 floating drift gillnet trips with 59 gear retrievals were observed. No marine mammal, sea turtle,

or seabird takes were documented.

No Monitors were deployed on float drift gillnet trips in 2010.

c) Otter Trawl Fisheries

In the bottom otter trawl fishery 1,152 trips were observed with a total of 10,848 gear retrievals recorded by Observers. In addition, there were 35 midwater trawl trips with 100 gear retrievals, 33 scallop trawl trips with 162 gear retrievals, 16 shrimp bottom otter trawl trips with 60 gear retrievals, three twin trawl trips with 44 gear retrievals, 29 haddock separator trawl trips with 798 gear retrievals and four Ruhle trawl with 119 gear retrievals were observed in 2010. In the bottom otter trawl fishery, there were 45 observed marine mammal takes (15 Risso's dolphins, eight common dolphins, seven whitesided dolphins, six bottlenose dolphins, six pilot whales, two gray seals, one harbor porpoise and one harbor seal). There were also takes of three loggerhead turtles, one unidentified hard-shell turtle, one leatherback turtle and 18 seabirds. In the mid-water trawl fishery, no marine mammal, sea turtle or seabird takes were observed. No marine mammal, sea turtle or seabird takes were observed. No marine mammal, sea turtle or seabird takes were observed. No marine mammal, sea turtle or seabird takes were observed. No marine mammal, sea turtle or seabird takes were observed. No marine mammal, sea turtle or seabird takes were observed. No marine mammal, sea turtle or seabird takes were observed. No marine mammal, sea turtle or seabird takes were observed. No marine mammal, sea turtle or seabird takes were observed. No marine mammal, sea turtle or seabird takes were observed. No marine mammal, sea turtle or seabird takes were observed. No marine mammal, sea turtle or seabird takes were observed. No marine mammal, sea turtle or seabird takes were observed. No marine mammal, sea turtle or seabird takes were observed. No marine mammal, sea turtle or seabird takes occurred in the shrimp bottom otter trawl fishery. In twin trawl trips, one northern gannet take was observed. Takes of two common dolphin and one pilot whale were observed on haddock separator trawl trips in 2010. One whitesided dolphin and one common dol

In 2010, At-Sea Monitors observed 723 bottom otter trawl trips with 6,689 gear retrievals, eight Ruhle trawl trips with 191 gear retrievals, and 39 haddock separator trawls with 1,062 gear retrievals. In the bottom trawl fishery, there were takes of 34 marine mammals (nine common dolphins, seven whitesided dolphins, seven pilot whales, five gray seals, two unidentified whales, one Risso's dolphin, one harbor seal, one unidentified seal and one unidentified baleen whale), one leatherback turtle, and 16 seabirds. In the Ruhle trawl fishery, Monitors documented takes of five common dolphins and two gray seals. On haddock separator trawl trips, Monitors observed takes of eight common dolphins, two gray seals, two pilot whales, and three seabirds.

d) Sea Scallop Dredge Fishery

In the 2010 sea scallop dredge fishery, 347 trips were observed with a total of 28,616 gear retrievals. Nine seabird takes were observed in the fishery.

No Monitors were deployed in the sea scallop dredge fishery in 2010.

e) <u>Scottish Seine Fishery</u>

No Scottish seine trips were observed in 2010.

No Monitors were deployed on Scottish seine trips in 2010.

f) Sink Drift Gillnet Fishery

In the 2010 sink drift gillnet fishery, Observers were deployed on 78 trips with a total of 436 gear retrievals. Five greater shearwater takes were recorded in this fishery.

Monitors were deployed on 13 trips with a total of 83 gear retrievals. Takes of one harbor porpoise, one harbor seal, and two greater shearwaters were documented.

g) <u>Anchored Floating Gillnet Fishery</u>

In 2010, 13 anchored floating gillnet trips with 27 gear retrievals were observed. No takes of marine mammals, sea turtles or seabirds occurred.

No Monitors were deployed on anchored floating gillnet trips in 2010.

h) Mid-water Pair Trawl Fishery

In the mid-water pair trawl fishery in 2010, 191 trips were observed with a total of 704 gear retrievals. Takes of seven marine mammals (two harbor seals, one unidentified dolphin, one common dolphin, one gray seal, one unidentified seal and one unidentified marine mammal) and 17 seabirds were recorded. No sea turtle takes were documented.

No Monitors were deployed on mid-water pair trawl trips in 2010.

i) Bottom Longline Fishery

In the 2010 bottom longline fishery, 62 trips were observed with a total of 342 gear retrievals. One greater shearwater take was observed in the fishery. No marine mammal or sea turtle takes were observed.

At-Sea Monitors covered a total of 112 bottom longline trips and 701 gear retrievals in 2010. Eight seabird takes were documented in the fishery. There were no marine mammal or sea turtle takes in 2010.

j) Beach Haul Seine Fishery

In the beach haul seine fishery in 2010, five trips were observed with a total of five gear retrievals. Two seabird takes were observed, but mo marine mammal or sea turtle takes were recovered.

No beach haul seine trips were covered by Monitors in 2010.

k) Pound Net Fishery

No pound net trips were observed in 2010.

No pound net trips were covered by Monitors in 2010.

l) <u>Handline Fishery</u>

Seven handline trips with 75 gear retrievals were observed in 2010, as well as two auto-jig handline trips with 33 gear retrievals. No trolling trips were observed in 2010. No marine mammal, sea turtle or seabird takes were observed in these fisheries.

Monitors covered 35 handline trips and 265 gear retrievals in 2010. There were no documented takes.

m) <u>Herring Purse Seine Fishery</u>

In 2010, 42 herring purse seine trips with 55 gear retrievals were observed. Four gray seal and two seabird takes were documented. No sea turtles takes occurred in 2010 in this fishery.

No herring purse seine trips were covered by Monitors in 2010.

n) <u>Menhaden Purse Seine Fishery</u>

In 2010, nine menhaden purse seine trips with 43 gear retrievals were observed. No marine mammal, sea turtle, or seabird takes were documented.

No menhaden purse seine trips were covered by Monitors in 2010.

o) Lobster Pot Fishery

In 2010, no lobster pot trips were covered by Observers or Monitors.

p) Fish Pot Fishery

In 2010, only one fish pot trip targeting groundfish encompassing four gear retrievals, and three hagfish pot trips with a total of 56 gear retrievals were observed. No marine mammal, sea turtle or seabird takes were observed.

No fish pot trips were covered by Monitors in 2010.

q) <u>Conch Pot Fishery</u>

No conch pot trips were covered by Observers or Monitors in 2010.

r) <u>Red Crab Pot Fishery</u>

No red crab pot trips were covered by Observers or Monitors in 2010.

s) <u>Clam Dredge Fishery</u>

No clam dredge trips were covered by Observers or Monitors in 2010.

t) <u>Scallop Beam Trawl Fishery</u>

No scallop beam trawl trips were covered by Observers or Monitors in 2010.

u) Electronic Monitoring System (EMS) Pilot Study

Amendment 16 to the Northeast Multispecies (Groundfish) Fishery Management Plan indicates that monitoring may become an industry responsibility in 2013, and encourages sectors to develop an adequate and independent third party at-sea/electronic monitoring program. To satisfy this requirement, the NEFSC Fisheries Sampling Branch (FSB) initiated in 2010 a multi-year pilot program (in conjunction with Archipelago Marine Research Ltd.) to test the applicability of electronic monitoring system (EMS) technology to collect catch and fishing effort data aboard commercial vessels. EMS technology involves the use of passive electronic systems (video cameras, sensors, and automated computers) to monitor various vessel activities, such as catch by species, fishing time, and fishing location. This project will test and evaluate the feasibility of EMS to monitor catch in the Northeast groundfish sector fleet as an alternative to human monitors. The project will assess the ability of the EMS technology to (a) monitor bycatch in real-time; correctly discriminate species in the catch (among the 13 quota groundfish species); and (c) obtain estimated catch weights remotely utilizing length approximations. The pilot study focuses on three primary fishing gears (gillnet, bottom otter trawl, and longline) deployed on a variety of representative vessels (size, fishing operation, boat set-up, etc.) in diverse geographies to evaluate the applicability of EMS technology. In the 2010 fishing year (May 2009 to through April 2011), 10 volunteer vessels participated in the EMS pilot study.

In fishing year 2010, EMS data were collected on 461 trips. Through comparisons of EMS data with other catch data reporting sources (observer/at-sea monitor, study fleet, VTR, dealer data), the effectiveness of EMS in sector fisheries will be assessed and a set of regulating criteria developed for monitoring operations plans. The final report (due out spring 2011) will include an inventory of all data and methods used in analyzing the EMS data sets. A technical assessment will also be provided of EMS in a variety of conditions, including instances where EMS may not be conducive to meeting monitoring objectives. For these situations, suggested alternatives will be identified. Report findings will also include recommendations for improvements to EMS technology, program design, and analytical procedures to better address fishery monitoring issues. A cost analysis of EMS as a monitoring tool will also be provided.

4. Population Dynamics Research

a) <u>Stock Assessments</u>

Population dynamics research conducted within the NEFSC supports a number of domestic and international fisheries management authorities. Within the United States Northeast Region, management plans are developed by the New England (states of Maine through Connecticut) and Mid-Atlantic (New York through North Carolina) Fishery Management Councils, and the Atlantic States Marine Fisheries Commission (ASMFC). There are about three dozen managed species; all require stock status updates as a basis for fishery management. Stock assessments are routinely reviewed in a peer review process termed the Stock Assessment Workshop (SAW). Stocks assessments conducted and reviewed through this process in 2010 include pollock, Atlantic sea scallop, longfin inshore squid, two silver hake stocks, two red hake stocks, and offshore hake.

Not all assessments conducted by the NEFSC are vetted at the SAW. Some are reviewed in the US/Canada Transboundary Resources Assessment Committee (TRAC). In 2010, stock assessments conducted and reviewed through the TRAC process included Eastern Georges Bank cod, Eastern Georges Bank haddock, and Georges Bank yellowtail flounder, as well as spiny dogfish and Atlantic mackerel. Other stock assessments in 2010 vetted in regional bodies included summer flounder, scup, black sea bass, bluefish, striped bass, and Northern shrimp.

b) Atlantic Salmon Research

Atlantic salmon populations in eastern Maine have been formally listed as endangered under the United States Endangered Species Act. 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, estuaries, and at sea. These data are used extensively in support of ICES stock assessment activities, and in the management activities of the North Atlantic Salmon Conservation Organization (NASCO).

Field research in 2010 focused on obtaining smolt production estimates, marine telemetry, and monitoring of fishery removals on the high seas. Smolt production in various rivers is monitored through the use of in-river traps. Trapping programs either generate population estimates via mark-recapture techniques or provide qualitative estimates via index monitoring. A large hatchery smolt tagging program has provided information useful in characterizing smolt emigration and adult returns in relation to stocking practices. Results from these studies indicate differential migration success in relation to stocking location and time, and have influenced resource management. Telemetry studies have identified significant mortality during the transition to the marine environment for both wild and hatchery reared smolts. Zones of increased mortality have been identified and potential causal mechanisms (poor physiological condition, predation) and evaluation of different hatchery products is being investigated through follow-up studies. Monitoring the West Greenland fishery and collecting biological data and fishery statistics continued in 2010. These data are provided directly to ICES and are required for North American run-reconstruction modeling and for developing catch advice for the fishery. All of these studies will contribute to recommendations for additional measures to be considered to halt the decline and restore the resource.

c) <u>Cooperative Research</u>

In FY 2010, the NEFSC Northeast Cooperative Research Program (NCRP) again received supplemental funding to help support the industry during the transition to Annual Catch Limits (ACLs) and sector management in Northeast groundfish fisheries.

With this funding, the NCRP provided additional support for an external competitive program through the Northeast Consortium which focused on conservation engineering studies to reduce bycatch and technology transfer to the industry. The NCRP also supplied 2010 funds to the Commercial Fisheries Research Foundation for a pilot study examining socioeconomic factors in the Rhode Island summer

flounder fishery. Awards made in 2009 to both of these groups resulted in over 17 cooperative projects that continued into 2010.

In addition, the NCRP published a 2010 Broad Agency Announcement (BAA) requesting research proposals to support the development of a conservation engineering and information technology network, in accordance with recommendations resulting from Strategic Planning initiatives concluded in 2009. Eight projects were awarded under this BAA, bringing together fishing industry, academic, and state and federal government partners to develop multi-disciplinary approaches to conservation engineering in Northeast and mid-Atlantic fisheries. This network comprises more than 80 individuals from 35 organizations to design, test, and demonstrate fishing gear that will improve the industry's ability to avoid bycatch of certain stocks so healthier stocks can be fully harvested. Studies are also bring conducted on patterns of fish distribution, environmental factors, enhanced mapping, and the real-time exchange of detailed information to identify bycatch hot spots so fishermen can avoid these areas.

Regional research teams in the networked projects are combining resources and expertise to develop and transfer new gear, information, and operating practices to the industry. Project participants include fisherman and gear manufacturers who provide ideas, at-sea expertise and guidance on larger scale testing of the most promising new gear designs. These teams are initially focused on 1) large mesh groundfish fisheries, 2) small mesh fisheries including squid in Southern New England and the mid-Atlantic, and 3) redfish in the Gulf of Maine. Two of the awards are to complete up to 20 gear demonstration and pilot projects for individual groundfish sectors and the common pool. Coordination of these network activities is being facilitated by NCRP staff members who are substantively engaged in providing technical and administrative support for network activities.

In 2010, a two-year cooperative trawl sweep comparison study was completed that evaluated the performance of cookie and rockhopper sweeps as they relate to catch efficiency of skates and flatfish (including winter, summer and yellowtail flounder). Between 2009 and 2010, the cooperative sweep comparison study consisted of more than 600 NEFSC staff sea days, completed 527 paired tows, and sampled more than 156,210 individual fish comprising 6 flatfish and 3 skate species. This study was conducted in Gulf of Maine, Georges Bank, and Southern New England waters, and catch rates and size composition across habitat types are now being analyzed. This information is expected to inform discussions on the need for a dedicated flatfish survey in the future, and will also be considered in the assessments of these species.

Fiscal year 2010 NCRP funds are also supporting three commercial vessels to participate in a cooperative initiative to tag spiny dogfish (*Squalus acanthias*) in the Gulf of Maine, Southern New England, and Georges Bank. This project will provide information on stock structure, movement patterns, and life history of the species to update and improve the stock assessment. Over a two-year period, approximately 33,000 dogfish will be tagged during the winter and summer seasons, with some fish double tagged (as part of a tag retention study) and/or injected with oxytetracycline for age validation.

Cooperative Research continues to support and grow the Electronic Logbook/Study Fleet Program, which focuses on using electronic reporting mechanisms for recording haul-based data (including temperature and depth profiles), and providing direct assistance to industry partners. In 2010, three solicitations were conducted for Study Fleet vessels, and the program currently has more than 25 vessels operating in the groundfish, squid, and Southern New England yellowtail fisheries. Currently, the Study Fleet electronic logbook is the only fishery dependent reporting system providing near real time tow-by-tow data to the NEFSC, often within 48 hours of a vessel completing a trip. Cooperative Research is seeking additional opportunities to expand the use of the Study Fleet Electronic Logbook system, known as FLDRS (Fisheries Logbook and Data Recording Software) in other cooperative studies and sectors.

The Study Fleet is also helping to address specific questions relating to yellowtail, summer, and winter flounder age, growth, maturation, and reproduction. In 2009 and 2010, over 3,000 additional samples were provided by Study Fleet vessels for analysis of age, diet, and spawning condition of these flounder species.

Continued funding in 2010 for the Environmental Monitors on Lobster Traps, or eMOLT program, was

provided by Cooperative Research funds through the Northeast Consortium. This partnership, involving NOAA, the State of Maine, the Commonwealth of Massachusetts, the Downeast and Atlantic Offshore Lobstermen's Associations, the Gulf of Maine Lobster Foundation, and the Marine Science Department at Southern Maine Community College (SMCC) in South Portland, Maine, facilitates environmental monitoring using a combination of temperature and current meter probes on lobster pots, as well as a series of GPS drifter deployments. The project continues to collect hourly bottom temperatures from nearly 100 fixed locations around the Gulf of Maine and the Southern New England Shelf. For more information and data access, visit: http://emolt.org.

In 2010, Research Set-Aside (RSA) competitions were held for Sea Scallops, Monkfish, and Mid-Atlantic Multispecies, with 11 projects awarded. Scallop RSA awards included support for resource assessments of Georges Bank Closed Area 1, Closed Area II, and the Hudson Canyon and Delmarva Closed Areas. Additional projects included a real-time electronic bycatch reporting pilot study, and testing of a turtle excluder dredge for bycatch reduction. Awards under the Monkfish RSA supported projects on the movement, growth, and habitat use of monkfish, as well as an evaluation of various tiedown lengths in monkfish gillnets on monkfish retention and bycatch reduction. Mid-Atlantic RSA awards included the Northeast Area Monitoring and Assessment Program Near Shore Trawl Program (NEAMAP), a fishery-independent scup survey of hard bottom areas in Southern New England, and a project to reduce butterfish retention in the offshore *Loligo* fishery using a bycatch reduction device adapted to pre-existing gear. In conjunction with the New England and Mid-Atlantic Fishery Management Councils, efforts continue to improve the efficiency and utility of the RSA programs.

d) Stock Assessment Methods Development

Many national and international studies have concluded that stock assessments should evaluate resource status using a number of different analytical approaches. 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 toolbox. The NOAA Fisheries Toolbox (NFT) incorporates a wide range of methods (such as virtual population analysis, reference point estimation, surplus production and forward-projection methods) into a stable environment with tested software products. The NFT is used for many routine assessment tasks. No new methods were added to the toolbox in 2010. The complete package may be accessed at http://nft.nefsc.noaa.gov/ (note that a password is no longer required).

e) Sea Scallop Research

Sea scallop research projects in 2010 included studies of the effects of environmental variables (e.g., predator abundances, primary production) on sea scallop recruitment and growth, and development of a towed optical survey (Habcam) for sea scallops and other benthic organisms.

f) Bigelow-Albatross Calibration

Work continued on calibrating the catches between the two vessels. Length-based calibrations were evaluated for cod, haddock, yellowtail flounder, silver hake, red hake, and longfin inshore squid. Several different methods were used, depending on the data available for specific species.



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



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



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



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



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



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



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



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



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



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



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



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



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



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



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



Figure 16. NEFSC autumn bottom trawl survey biomass indices for Atlantic halibut.



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



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



Figure 19. NEFSC spring bottom trawl survey biomass indices for northern red hake.



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



Figure 21. NEFSC spring bottom trawl survey biomass indices for Atlantic herring.



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



Figure 23. NEFSC autumn bottom trawl survey biomass indices for butterfish.



Figure 24. NEFSC autumn bottom trawl survey abundance indices for longfin inshore squid.



Figure 25. NEFSC autumn bottom trawl survey abundance indices for northern shortfin squid.



Figure 26. NEFSC scallop survey biomass indices for Georges Bank sea scallops.



Figure 27. NEFSC scallop survey biomass indices for Mid-Atlantic Bight sea scallops.



Figure 28. ASMFC summer shrimp survey biomass indices for northern shrimp.



Figure 29. NEFSC spring survey biomass indices for spiny dogfish.



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



Figure 31. NEFSC spring survey biomass indices for little skate.



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



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



Figure 34. NEFSC autumn survey biomass indices for smooth skate.



Figure 35. NEFSC autumn survey biomass indices for clearnose skate.



Figure 36. NEFSC autumn survey biomass indices for rosette skate.