
Recent Accomplishments and Research Priorities for FY 2001-2006

I. Research to support fishery conservation and management

Recent Accomplishments:

Studies on the basic biology, movement, and population status of North Pacific swordfish were completed to provide the WPFMC up-to-date information for the management of its longline fishery. Similar information was provided on the status of the blue shark; in both cases the stock assessments indicated these populations were being managed in a sustainable manner. Subsequent analyses are underway for blue and striped marlin, other tuna, and miscellaneous pelagic species. This work has involved collaboration with fisheries scientists from around the Pacific, particularly with Japanese scientists.

A multi-national synoptic survey of krill biomass of Antarctic Statistical Subarea 48 (Peninsula, S. Orkney, S. Georgia, and S. Sandwich) was completed. As a result of a five-year planning effort, one ship from the U.S., United Kingdom, Japan, and Russia each conducted a one-month acoustic/oceanographic survey of the above areas and the open-ocean areas between each island group. This was a CCAMLR-sponsored survey with the participation of scientists from the International Whaling Commission. The U.S. convened a CCAMLR workshop to complete analyses of survey data.

The Groundfish Program provided PFMC with stock assessments for bocaccio rockfish, widow rockfish, canary rockfish (south), and lingcod (south), as well as rebuilding analyses for bocaccio rockfish and Pacific ocean perch. SWFSC staff initiated and convened a review of harvest rates for west coast groundfish, resulting in significant revision of PFMC management policy. Midwater trawl surveys provided annual indexes of rockfish recruitment strength for use in stock assessments and analyses of environmental influences.

A recent analysis of atmospheric observations in the North Pacific revealed extensive decadal-scale variations in the mid-latitude winter surface wind stress. In the decade after the winter of 1976, eastward wind stress doubled over a broad area in the central North Pacific and the core of the North Pacific Current was displaced about 360 nautical miles southward. The result was that surface water entering the California Current was of more subtropical origin in the post-1976 decade. All factors considered contributed to a multi-decadal temperature pattern of warm, nutrient-poor surface waters in the California and Alaska current regions. In association with the 1976 climatic shift, marine fishery production in the Oyashio, California, and Alaska currents altered dramatically, suggesting that natural environmental variation significantly alters the long-term yields from many North Pacific fisheries.

Research Priorities, FY 2001-2006:

I.A. Biological research concerning the abundance and life history parameters of fish stocks

- Conduct biological research by the U.S. Antarctic Marine Living Resource Program concerning abundance and life history parameters of fish stocks.
- Plan, conduct, and present results of annual predator/prey interaction studies in waters around South Shetland Islands, Antarctica.
- Understand the stock dynamics and influence of environmental conditions on the NWHI spiny and slipper lobster.
- Complete assessments of the coral reef ecosystems of the central and western Pacific.
- Develop a new Bayesian method of stock assessment for application to data-poor groundfish species.
- Develop a groundfish survey using chartered commercial fishing vessels for the Southern California Bight.
- Develop a population genetic database of all anadromous California salmonid stocks for determination of stock structure and as a baseline for future monitoring efforts.
- Provide quantitative estimates of the take of listed salmon in the California salmon harvest and evaluate proposals to minimize list species take.
- Publish *Rockfishes on the Northeast Pacific*, a comprehensive book on the identification, description, biology, distribution, conservation, and fisheries of 72 species of rockfishes recorded from Mexico to Alaska.
- Assist the California Department of Fish and Game in developing a system of marine protected areas for California nearshore waters.
- Implement an archival tagging program for North Pacific albacore in cooperation with the albacore fishing industry, Japanese fishery agencies, and other groups to trace their movements between fisheries and countries.
- Define unit stocks using genetics and otolith chemistry in highly migratory species (albacore, thresher shark, and striped marlin), in coastal pelagic species (sardine), and in groundfishes (cabezon, Puget Sound and coastal brown rockfish, and other rockfishes).

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- Conduct peer-reviewed assessments and statistical analyses on stocks of groundfish, coastal pelagics, tunas, sharks, swordfish, salmon, and other species.
 - Develop a new generation of stock assessment models for highly migratory species and coastal pelagic species stocks of the Pacific and the state-of-the-art software to support them, using modern statistical optimization techniques, Bayesian methods, and object-oriented programming languages.
 - Use pop-up satellite tags to identify forage and migration habitats of exploited species and protected resources in the central and western Pacific.

I.B. Social and economic factors affecting abundance levels

- Expand sociological and economic research and incorporate results into the fishery management process.
- Develop behavioral models of economic incentives affecting the level and allocation of fishing effort in FMP fisheries.
- Initiate an economic survey of salmon commercial troll fishery.
- Enhance existing salmon harvest models to better predict fishing effort response to changes in sport and commercial fishery regulations.
- Conduct RIRs and RFAs for management actions being considered for all FMP fisheries.
- Evaluate growth in productivity for purse seine vessels harvesting tuna in the western and central Pacific, paying special attention to the effects of fish aggregating devices (FADs).

I.C. Interdependence of fisheries or stocks of fish

- Complete research program under the International Dolphin Conservation Protection Act to determine whether the chase and encirclement by the fishery is having a significant adverse impact on depleted dolphin populations in the eastern tropical Pacific.
- Design sampling surveys to analyze the impact of marine mammals on listed salmon.
- Develop integrative oceanic environmental indices to improve understanding of how environmental variability affects fish stocks.

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- Extend analysis of factors affecting longline-turtle and longline-sea bird interactions to include more detailed oceanographic, tagging, and behavioral analysis.
 - Evaluate the foraging ecology of the Hawaiian monk seal in terms of its use of fishery resources such as lobsters and bottomfish.
 - Initiate studies of trophic ecology and growth biology of billfish and miscellaneous pelagic species (e.g., mahimahi, ono, moonfish).
 - Integrate central Pacific pelagic ecosystem monitoring with stock assessments.
 - Use ecosystem models such as Ecopath with Ecosim to describe ecosystem structure and dynamics for pelagic and insular ecosystems.

I.D. Identifying, restoring, and mapping of essential fish habitat (EFH)

- Participate in salmon EFH identification and protection.
- Develop and produce digital mosaics of seafloor habitats from electro-optic images into a format compatible with other geo-referenced data sets used in GIS.
- Develop approaches to evaluate essential habitat of pelagic fishes based on satellite remote sensing and applications of archival and pop-up satellite tags.
- Conduct baseline assessments and map major habitats of the coral reef ecosystem in the central and western Pacific (American Samoa, Guam, Hawaii, the Northern Mariana Islands, and remote Pacific islands).
- Investigate sources and ecosystem impacts of marine debris and identify mitigation measures.
- Evaluate EFH and monitor marine resources in newly created “no-take” marine reserves planned for the Channel Islands National Marine Sanctuary.
- Define essential spawning habitat of market squid and the effects of fishing gear on that habitat and the survivorship of demersal egg capsules.

I.E. Impact of anthropogenic factors and environmental changes on fish populations

- Estimate the impact of marine debris on the health of coral reef ecosystems.

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- Investigate relationship of juvenile salmon abundance and physiological status with respect to oceanographic features (e.g., estuary plumes, upwelling centers, coastal jets, eddies, and fronts).
 - Determine the effects of hatchery and aquaculture operations on indigenous salmon and steelhead stocks in California by molecular genetic analysis of museum specimens and previously collected scale samples.
 - Evaluate the effects of climate change of interannual, decadal, and centennial scales on fisheries and fish habitat.
 - Develop models of the impacts on salmon populations of natural disturbances due to climatologies.
 - Improve methods to identify pathways in estuarine ecosystems for the bio-accumulation of contaminants in salmon.
 - Examine the association of recruitment of young rockfishes and climatic and oceanographic variables off central California.
 - Investigate use of small estuaries on central California coast by juvenile salmonids. Assess the effects of environmental variability, particularly sandbar dynamics and water quality, on growth, development, and survival.
 - Investigate the linkage between the dynamics of oceanic features, including eddies, fronts, and boundary currents, and the dynamics of highly migratory fishes (tunas and billfishes) in the central and western Pacific.

II. Conservation engineering research

Recent Accomplishments:

A carefully constructed experimental design for testing alternative methods to avoid longline interactions with sea birds was completed. It identified several key methods for mitigating such impacts. These results were combined with WPFMC-supported research aboard commercial longliners to gain industry support of mitigation techniques and have been proposed by the Council as management regulations.

A comprehensive multi-agency program was initiated to remove marine debris from the NWHI coral reef ecosystem as a means to reduce impacts on the corals and to reduce mortality of the Hawaiian monk seal. To date, hundreds of tons of debris have been removed and the program will continue for the next two years. The Habitat Restoration Cost Workshop was convened in Portland, OR, in November 2000 to evaluate the feasibility of developing and applying standardized methodologies for estimating salmon habitat restoration costs, which would then

be used for salmon recovery planning. Restoration topics covered by the workshop included road maintenance and road decommissioning, streambanks stabilization, instream treatment, fish passages and fish screens, and wetland creation and restoration. Presentations were made by engineers, biologists, hydrologists, geologists, foresters, and economists representing Federal, state, and local agencies and the private sector.

An analysis of acoustic backscatter from an acoustic Doppler current profiler (ADCP) and surface temperature and salinity continuously sampled in relation to the continuous underway fish egg sampler provided a description of the sardine spawning habitat. This detailed observational analysis shows, on a survey-by-survey basis, that eggs and larvae are found in waters that are transitional between those that are freshly upwelled and those of the California Current proper.

The SWFSC completed research to improve our understanding of fisheries impacts on marine ecosystems. The study pioneered the use of the combination of acoustic techniques, fishing information, and direct submersible research to directly evaluate deepwater fisheries habitat. Research published in the past year considered the potential of side-scan sonar to enumerate the frequency of trawl tracks on soft bottom environments, suggesting that acoustic remote sensing is a promising independent approach to evaluate fishing effort on a scale consistent with commercial fishing activities.

Research Priorities, FY 2001-2006:

- Undertake studies to determine the best methods to increase survival of protected, prohibited, or sensitive species caught by longline and troll vessels.
- Determine how to increase survival in the economic/regulatory discards of undersized tunas, sharks, and other fishes.
- Create and test new trap designs for juvenile out-migrant salmon that will minimize predation on juveniles from larger salmonids (in cooperation with Humboldt State University).
- Investigate methods for reducing longline interactions with sea turtles, including at-sea experiments with the commercial longline fleet.
- Develop GIS applications for mapping the NWHI lobster and bottomfish habitat, as well as identifying inter-relationship of precious (gold) coral and Hawaiian monk seal habitat.
- Conduct baseline rapid environmental assessments of the condition and health of some of the most remote and pristine coral reef ecosystems of the U.S.-affiliated Pacific Islands.
- Assess and monitor, with remote sensing, the marine debris in the NWHI.

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- Establish a program to monitor the health of coral reef ecosystems, including remote sensing.
 - Develop advanced survey technology for monitoring abundance of fishes including: (1) use of LIDAR for monitoring the abundance of CPS species; (2) remote monitoring of FAD fish aggregations; and (3) species identification algorithms for acoustic surveys.
 - Develop advanced technology for automatic shipboard data logging of bio-acoustic and environmental data from standard equipment on commercial fishing vessels and logging of catch. Develop algorithms for processing and analysis of these data.

III. Research on the fisheries

Recent Accomplishments:

The SWFSC initiated and led the efforts to evaluate MPAs as a supplemental tool for groundfish management on the west coast. The Center organized and convened the first workshop on marine harvest refugia to conserve and manage rockfish and continued these discussions in a special symposium on marine protected areas for California. The published proceedings and reports are also being used by west coast states in evaluating marine reserves as a strategy to conserve and manage nearshore marine resources. Similar studies are underway in Hawaii to evaluate State of Hawaii area closures designed to rebuild populations of several commercially important bottomfish species.

General additive model (GAMs) were estimated from detailed observations gathered from NMFS-SWR observers and high-resolution environmental data, merged with fishery logbook data to assess the impact of time-area closure alternatives on the Hawaiian longline fishery. The results from these models were used in litigation concerning the impact of the Hawaiian longline fishery on sea turtles and to propose efficient regulatory alternatives. The analysis used a financial portfolio analysis to estimate the efficacy of various scenarios.

Coho salmon production in the Pacific Northwest reached historically low levels in the 1990s, which stimulated research examining whether changes in ocean conditions were responsible for inter-annual variability in the ocean survival of coho. Recent investigations focused on improving the measures of ocean conditions using remotely-sensed sea surface temperature (SST) data and by weighting upwelling indices with sea surface temperatures. The models generated from the analyses may have the potential to be used for coho survival forecasting. Related research evaluated how spatial patterns of environmental variability may differentially affect parts of the coho populations.

The SWFSC completed an analysis of harvesting capacity in the Pacific coast CPS limited entry finfish fishery. The Center also collaborated on an analysis of harvesting capacity in the Pacific coast market squid fishery.



Trawl-caught California market squid.

Multifan CL was applied to develop stock assessments for highly migratory species.

Research Priorities, FY 2001-2006:

III.A. Social and economic research

- Initiate economic evaluation of salmon hatchery reform actions.
- Develop automated analytical templates integrated with current fishery performance, cost, and price information for completing RFAs in an efficient and timely basis. Augment these templates to include the basic demographic information required to initiate preliminary SIAs.
- Conduct research to support the United Nations Implementing Agreement (or Provision of the United Nations Convention on the Law of the Sea (UNCLOS) Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks).
- Research intra-industry linkages and develop input-output relationships to describe and model the employment, income, and economic activity impacts of management actions being considered for each of the FMP fisheries and fishing communities.
- Develop methods to assess the efficacy of various MPAs, ecosystem preserves, and other time-area closures in restoring fish stocks and increasing sustainable yields.

III.C. Marine aquaculture

- Develop techniques for culture of white abalone and other abalone species for recovery of endangered stocks, stock enhancement, and commercial production.

IV. Information management research

Recent Accomplishments:

The SWFSC's Pacific Fisheries Environmental Laboratory (PFEL) provides environmental data for fisheries research and management. Environmental variability has been identified as a key feature in fish and marine mammal population dynamics. PFEL's data holdings and related data products provide fisheries relevant data that cover the entire spectrum of the ocean environment—from surface or near-surface wind and pressure data that can affect the ocean, to surface and subsurface measurements of important oceanographic parameters. Over the last year, PFEL has developed a system to make this information readily accessible to fisheries scientists. Scientists can now obtain over the Internet most of the PFEL's data holdings,



CTD array is deployed off NOAA R/V *Miller Freeman* to take conductivity, temperature, and depth measurements.



NMFS scientist measures wire angle to deploy CTD array.

for any location in the world. The data can be sorted in both space and time, visualized on-line, and downloaded in a variety of formats. Data and expertise were provided to researchers working on salmon survivorship, hake catches and negotiations with Canada, harmful algal blooms, rebuilding overfished fish stocks, benthic fauna patterns in sanctuary areas, and marine mammal population dynamics.

Data collected and processed from U.S. purse seiners fishing in the central-western Pacific was computerized, edited, and submitted to the Forum Fisheries Agency (Treaty Manager) as required under the SPTT. This information was reported at the Annual Treaty meeting of the Forum Fisheries Agency in Nuie and also presented at the meeting of the Standing Committee of Tunas and Billfish in New Caledonia for use in stock assessments of central-western Pacific skipjack, yellowfin, and bigeye tuna stocks.

The SWFSC fielded three observers aboard U.S. troll vessels to collect length measurements of albacore and bycatch estimates to verify and supplement data taken by port samples and in logbook records. The data was computerized and presented to the North Pacific Albacore Workshop in Taiwan and used to assess the status of Pacific albacore stocks. This data was also analyzed and distributed to U.S. albacore fishers.

Conductivity, temperature, and depth studies at a series of stations along the NWHI were initiated in May 1999 to begin a long-term time series of vertical structures of the physical environment affecting fisheries. This information is being integrated in a GIS application with fisheries information and NOAA R/V *Townsend Cromwell* information to develop a series of applications for detailed location-referenced studies.

Federal logbook and permit data from the rapidly growing American Samoa longline fishery were developed into an integrated data management system by the WpacFIN program which has allowed rapid use of the information for assessing management measures considered for the fishery by the WPFMC. The information is collected and compiled by the government of American Samoa fisheries office where hands-on quality control and delinquency analysis can be conducted in conjunction with the NMFS Office of Enforcement. Data and statistics are then available through Internet connections to the Honolulu Laboratory.

Research Priorities, FY 2001-2006:

- Implement an Oracle-based integrated system for storing and distributing via the Internet all of the Honolulu Laboratory data holdings, including fisheries dependent, research cruise, remote sensing, laboratory, and video data.
- Develop automated systems for integrating data sets with common fields (e.g., longline logbook and observer reports, the NOAA R/V *Townsend Cromwell* cruise reports, and remote sensing).
- Develop GIS technology for mapping and spatial analysis of fisheries, oceanographic, and habitat information.

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- Automate quarterly and annual compilation of fisheries statistics and annual reports on FMP fisheries.
 - Develop and maintain web-based coastal salmon abundance database.
 - Advance approaches of data fusion to combine fisheries data and assessment model outputs with environmental data from ship, satellite, and physical models.

Southeast Fisheries Science Center (SEFSC)

The Southeast Fisheries Science Center (SEFSC) is headquartered in Miami, FL. The SEFSC is responsible for scientific research on living marine resources that occupy marine and estuarine habitats of the continental southeastern United States, as well as Puerto Rico and the U.S. Virgin Islands. Research is conducted at laboratories located in Beaufort, NC (a joint NOS-NMFS facility); Miami, FL; Panama City, FL; Galveston, TX; and Pascagoula, MS, with a field station at the Stennis Space Center. Two NOAA vessels assigned to fisheries research are also homeported in Pascagoula: the NOAA R/V *Oregon II* and the NOAA R/V *Gordon Gunter*. SEFSC's current staffing level is 258 FTEs, with all positions involved in MSFCMA-related activities. Approximately 80% of all SEFSC resources are assigned to MSFCMA activities.



Southeast Fisheries Science Center Miami Laboratory and Headquarters, Miami, FL.

In general, SEFSC develops the scientific information required for: (1) fishery resource conservation, (2) fishery development and utilization, (3) habitat conservation, and (4) the protection of marine mammals and endangered species. Impact analyses and environmental assessments for management plans and international negotiations are also prepared, and research is pursued to address specific needs in population dynamics, fishery biology, fishery economics, engineering and gear development, and protected species biology.

Each SEFSC laboratory is responsible for conducting research in specific subject areas, however, there is extensive cooperative research between SEFSC laboratories. Research activities conducted by the various laboratories are as follows:

Beaufort Laboratory: habitat research; fishery biology and stock assessments, especially for reef fish; population dynamics of menhaden, weakfish, red drum, etc.; protected species research.

Miami Laboratory: stock assessments for species such as snapper-grouper, mackerels, highly migratory species (e.g., sharks, swordfish, tunas, and billfish), sea turtles, marine mammals, and other endangered or threatened species; research on coral reefs, MPAs, and the South Florida ecosystem restoration program.

Panama City Laboratory: fishery biology and life history characteristics and essential fish habitat research.

Mississippi Laboratories: fishery-independent surveys; gear development (TEDs and BRDs); environmental remote sensing; bycatch; and endangered species research.

Galveston Laboratory: fishery biology and stock assessment of shrimp populations; gear and bycatch evaluation studies; habitat research and restoration; and endangered species.

SEFSC provides scientific support for NMFS' fishery management activities for the South Atlantic Fishery Management Council (SAFMC), the Gulf of Mexico Fishery Management Council (GMFMC), and the Caribbean Fishery Management Council (CFMC), that involve 17 fishery management plans covering the following major fisheries: spiny lobster, snapper-grouper, reef fish, red drum, coastal migratory pelagic species, coral, shrimp, stone crab, queen conch, and golden crab. SEFSC also has significant interactions with the Gulf States Marine Fisheries Commission (GSMFC), which administers the Fisheries Information Network (FIN) statistics effort; and the Atlantic States Marine Fisheries Commission (ASMFC), which administers the ACCSP and exercises fishery management responsibilities through the Atlantic Coastal Fisheries Cooperative Management Act. In addition, SEFSC maintains close ties with state fishery programs and has funded the State/Federal cooperative statistics program since 1983. Researchers at the SEFSC collaborate extensively with other Federal agencies and academia.

Internationally, the SEFSC provides scientific support for U.S. participation in: (1) the International Commission for the Conservation of Atlantic Tunas (ICCAT), which manages Atlantic Ocean-wide fisheries for tunas and billfishes; and (2) the International Oceanographic Commission for the Caribbean (IOCARIBE), which coordinates fishery oceanography studies among the approximately 30 islands and continental countries in the region. SEFSC scientists also work jointly with the government of Mexico on projects of mutual interest in the Gulf of Mexico under the Mexus-Gulf research working group.

Constituents have the opportunity to provide input to SEFSC's research programs through representation on FMCs, participation in Council public hearings, and service on Council advisory committees. Input to the SEFSC research program is also received via the activities of interstate fishery commissions (the Atlantic and Gulf States Marine Fisheries Commissions), joint agency planning groups, and cooperative programs with state fishery agencies (GulfFIN). SEFSC responds to the information needs of fishery management councils and has a formal procedure (Council Operations Plan) for matching its research program to fishery management plan requirements.

SEFSC's high caliber of research is maintained through periodic program reviews by teams that include officials from industry, councils, state agencies, universities, and other constituents. The Center also works diligently to be responsive to the results of program reviews.

Recent Accomplishments and Research Priorities for FY 2001-2006

I. Research to support fishery conservation and management

Recent Accomplishments:

SEFSC has successfully incorporated “risk assessment,” “uncertainty,” and the new SFA guidelines on “overfished” and “overfished status” into stock assessment methodologies for numerous species in the Gulf of Mexico, Atlantic, and Caribbean.

The development of the red snapper rebuilding plan was based on SEFSC scientific efforts.

The Center is recognized for its expertise in the fields of habitat research and restoration and has successfully developed criteria to define and assess areas of EFH.

SEFSC completed baseline data collection essential for the successful establishment of marine reserves in the Tortugas region for the Florida Keys National Marine Sanctuary and for the Dry Tortugas National Park.

Research Priorities, FY 2001-2006:

I.A. Biological research concerning the abundance and life history parameters of fish stocks

- Further efforts to improve the effectiveness of fishery resource management programs by refining the definition of stocks (including the “management unit” within species), and to determine data needs and analytical methods required for applying refined definitions.
- Develop and maintain high quality fishery-dependent and fishery independent long-term data sets for stock assessments. A main component of this effort will be the expanded use of at-sea observers on commercial and recreational fishing vessels to report on catch and bycatch. Emphasis will be on collecting a wide range of information, including biological and environmental data, gear type deployed, and method of deployment.
- Incorporate marine ecosystems data into conceptual models of food webs to link habitat to productivity and increase the Center’s ability to survey, inventory, and understand the dynamics of marine systems and their biota.
- Continue to assess and monitor protected finfish species (e.g., jewfish and Nassau grouper).



NMFS scientist measures fish, aboard R/V *Oregon II*.

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- Conduct research on HMS stocks, particularly in the areas of stock identification, life history, and precautionary approach methodologies.
 - Develop basic life history information and conduct assessments on fish stocks in support of management for the Councils (SAFMC, GMFMC, and CFMC) and Commissions (ASMFC, GSMFC).

I.B. Social and economic factors affecting abundance levels

- Expand sociological and economic research and incorporate results into the fishery management process.

I.C. Interdependence of fisheries or stocks of fish

- Increase our understanding of the interactions of protected species (e.g., sea turtles, marine mammals: bottlenose dolphin and large whales) and finfish candidate species (e.g., jewfish and Nassau grouper) with ongoing fisheries in the Southeast Region.
- Prevent the extinction and promote the recovery of marine species and at-risk populations through interventions and the continued development of recovery strategies.
- Develop scientific methodology for multi-species or ecosystem approaches towards the management of fishery resources, and where appropriate, transition from single-species approaches.

I.D. Identifying, restoring, and mapping of essential fish habitat (EFH)

- Define and characterize EFH and develop an understanding of natural and anthropogenic threats.
- Investigate downstream and coastal impacts of agricultural and urban activities and provide the technical basis for designing and implementing programs for ensuring sustainable coastal communities.
- Gain a better understanding of the structure and function of estuarine, coastal, and marine systems to enhance the conservation and restoration of wetland, benthic, and aquatic areas of EFH.
- Explore innovative techniques to determine the functional value of natural habitats and to evaluate the restoration success relative to the fish community rather than solely to the plant community.
- Develop restoration techniques for EFH including corals, salt marshes,

and seagrasses; and determine whether habitats created or restored with such techniques are ecologically functional.

I.E. Impact of anthropogenic factors and environmental changes on fish populations

- Continue to engage in joint efforts with state and other Federal agencies to restore the ecological integrity and water quality in Florida Bay, Galveston Bay, and other estuaries upon which fish depend.
- Continue research efforts under the South Florida Restoration Effort, particularly in the areas of modeling fishery dynamics, recovery of protected resources, restoring EFH, and providing support for the Coral Reef Initiative.
- Derive more accurate assessments of fishing and other anthropogenic impacts on living marine resources by incorporating risk and uncertainty into models used to predict natural living marine resource variations.
- Develop techniques and scientific data necessary to support the effective application of precautionary approaches to fisheries management.
- Continue to evaluate the efficacy of marine reserves, no-take and limited-take zones, and time closures as fishery management tools.

II. Conservation engineering research

Recent Accomplishments:

Innovative approaches to BRD design have been developed. For example, SEFSC has conducted *in situ* observations of red snapper behavior during shrimp trawling to aid in the design of more effective BRDs and has successfully led efforts to significantly reduce the bycatch of non-target species such as red snapper in the Gulf of Mexico shrimp fishery.

The development and use of improved TEDs is contributing to the recovery of sea turtles, especially Kemp's ridley in the southeastern region.

A recovery model for impacted subtropical seagrass habitats was developed and has been used successfully in court to demonstrate impacts to sanctuaries.

Research Priorities, FY 2001-2006:

- Continue investigations on the importance of environmental cues in the spatial orientation and migration behavior of sea turtles.
- Develop and test new gear technology and fishing techniques to minimize bycatch. The SEFSC continues to explore options to reduce bycatch and

mitigate mortality of sea turtles and other non-target species captured in the distant water longline fisheries.

- Develop and test new gear technology and fishing techniques to minimize adverse impacts on EFH. The Center will continue to document the extent and assess the impact of various fishing gears on EFH in support of conservation and management activities.
- Promote efficient harvest of target species. The Center will conduct investigations into limited access options (e.g., individual transferable quotas (ITQs)) as resource management alternatives that aid increased harvest efficiency are continuing.

III. Research on the fisheries

Recent Accomplishments:

Economic information, analyses, and evaluations were provided for numerous proposed fishery management actions in the southeast.

SEFSC developed and assisted in the collection of economic data through special surveys of the commercial snapper-grouper and mackerel fisheries.

SEFSC, in conjunction with academic economists, contributed to the development of random utility and contingent valuation models of the South Atlantic and Gulf of Mexico recreational fisheries.

Research Priorities, FY 2001-2006:

III.A. Social and economic research

- Include socio-economic related questions in the log book program and increase the use of information such as cost and return data in fisheries management.
- Design and implement procedures to collect socio-economic data on a routine basis. Data would be used to better determine the effects of regulation on commercial and recreational fishers.
- Develop better models of commercial and recreational fisheries to evaluate proposed management alternatives, including limited access systems.
- Estimate economic relationships such as demand curves, production functions, import supply curves, and recreational benefit functions needed to support the evaluation of management decisions.

III.B. Seafood safety research

- Support research aimed at identifying and characterizing marine pathogens, especially viruses, in aquacultured shrimp products, and the extent of viruses in wild shrimp stocks.
- Continue to develop biological and chemical analytical methods for toxic contaminants (e.g., mercury), assess their presence in seafood, and define their impacts on marine ecosystems.
- Improve methods to detect, forecast, and evaluate the ecological significance of harmful algal blooms and their impact on fish stocks, marine mammals, and other protected species.

III.C. Marine aquaculture

- Develop the scientific foundation and technical guidelines for establishing ecologically responsible marine aquaculture.
- Continue to investigate the natural occurrence of shrimp viruses.

IV. Information management research

Recent Accomplishments:

SEFSC has developed and implemented a fully integrated Oracle-based fisheries logbook system.

Research Priorities, FY 2001-2006:

- Develop a fishery database and information management system that will allow the full use of information in support of effective fishery conservation and management.
- Fully integrate the logbook system with the regional permit database.
- Increase collection of observer-based data on bycatch and improved fishery-dependent data (e.g., via ACCSP's program with ASMFC).
- Secure access by constituents and the public to SEFSC information resources via web-based technologies.

Northeast Fisheries Science Center (NEFSC)



Northeast Fisheries Science Center Woods Hole Laboratory, Woods Hole, MA.

The Northeast Fisheries Science Center (NEFSC) has facilities in Woods Hole, MA; Narragansett, RI; Milford, CT; Sandy Hook, NJ (James J. Howard Marine Laboratory space rental from the state of New Jersey), and supports staff at the National Systematics Laboratory (housed at the Smithsonian Institution in Washington, DC.). The NOAA R/V *Albatross IV* and NOAA R/V *Delaware II*, berthed in Woods Hole, MA, support the majority of the Center's fisheries survey and research cruises. Periodically, the NOAA R/V *Gordon Gunter* and NOAA R/V *Oregon II* (berthed in Pascagoula, MS) are utilized as supplemental sources for either surveys or research cruises. Private fishing vessels and academic research ships have been utilized on a periodic basis to support ecosystem surveys on the northeast continental shelf.



James J. Howard Marine Laboratory, Sandy Hook, NJ.

The NEFSC research program runs the gamut from stock assessments on finfish populations during the Spring and Fall Bottom Trawl Surveys (conducted annually since the 1960s) to process-oriented research projects such as studying the impacts of global climate change on the coupling of zooplankton/cod and haddock larvae distribution and predation on Georges Bank. Additional fisheries surveys are conducted for ocean quahogs, surf clams, and sea scallops, and grant funds are provided to support surveys of Gulf of Maine northern shrimp and finfish surveys in state waters. Stock assessment workshops (SAWs) involving the participation of fisheries experts from state, academic, and non-government organizations (NGOs) use this survey data to develop consensus estimates of stock size for managed species of finfish and shellfish. The Mid-Atlantic Fishery Management Council (MAFMC) and the New England Fishery Management Council (NEFMC) then uses this advice.

Long-term changes in the ecosystem supporting fisheries are monitored through surveys of the Northeast Shelf Large Marine Ecosystem (LME) and research is underway to convert such data into indices on the health of the ecosystem. Additional process-oriented research projects focus upon the effects of pollution on winter flounder; recovery of herring and Atlantic mackerel populations; trophic interactions between Atlantic mackerel, juvenile cod, and haddock; biological characteristics of selected shark species in the Northeast; and descriptions of EFH for most coastal finfish species. The Center also conducts social and economic research in support of the fishery management process.

Reliable information, critical to the development of regional FMPs and subsequent amendments, and, ultimately, to the building and maintenance of sustainable fisheries, is produced through the Northeast Regional SAW process. This process is a cooperative effort of the NMFS/NEFSC and Northeast Region Office (NERO), NEFMC, MAFMC, and the ASMFC. In the northeast, peer review of stock assessments is conducted twice per year within the Northeast Regional SAW process. The SAW process is guided by the SAW Steering Committee (directors of NEFSC and NERO, MAFMC, NEFMC, and the ASMFC) which determines the species to assess during a particular SAW cycle and establishes the assessment terms of reference. Each SAW cycle begins and ends with the meeting of the

SAW Steering Committee and includes Working Group meetings (where analyses are prepared for review); a five-day Stock Assessment Review Committee (SARC) meeting (where analyses are peer-reviewed and advice for managers is developed); and a two-to-three-session Public Review Workshop held during planned meetings of the MAFMC, NEFMC, and ASMFC. Participants in this process include NMFS scientists and managers; representatives from fishery agencies outside the region; MAFMC, NEFMC, and ASMFC representatives; state fishery agency representatives from within the region; academic and NGO participants; industry members; and occasionally experts from the international community. SAW meetings are open to the public and are widely announced. NEFSC personnel also participate in various committee meetings of the Regional FMCs and the ASMFC.

Much of the recent gear research in the northeast has been accomplished through grants, with NERO oversight. These grants have gone to fishers, or to organizations such as states and universities, which carry out the research with the help and cooperation of the fishing industry. The NERO Fisheries Engineering Group is also involved with data analysis for exempted fishery permits and fishway engineering for anadromous fish. Conservation engineering activities in the NERO have recently been concentrated on the problem of entanglement of large whales in fixed fishing gear (e.g., lobster traps and gillnet gear). A resolution to this problem will allow fishing to continue. The fishing industry aided this effort through its participation in the Gear Advisory Group to the Atlantic Large Whale Take Reduction Team to devise solutions, and by volunteering vessels and time for observations and testing. Also, NERO and the Center are collaborating on experiments using pingers and acoustic reflective nets as deterrents to marine mammal entrapment in gillnets.

Recent Accomplishments and Research Priorities for FY 2001-2006

I. Research to support fishery conservation and management

Recent Accomplishments:

Rates of growth, development, and survival have been estimated for the larval goosefish.

Rates of growth, development, survival, and how these vary with water temperature, have been estimated for the egg, larval, and juvenile stages of summer flounder and winter flounder.

The NEFSC has demonstrated that the technique of using scale texture for sexing winter flounder is invalid.

Measures of egg quality and parental effects on offspring condition have been quantified for summer flounder and winter flounder.



NMFS scientist deploys bongo nets with Seacat instrumentation to support studies on the growth and survival of fish larvae.

The influences of the timing and location of spawning of summer flounder on offspring fitness have been estimated.

Data have been gathered on the timing and location of goosefish spawning.

Field work in the U.S. GLOBEC program on Georges Bank has been conducted. The program is investigating the environmental and biological processes controlling the reproductive success of the cod and haddock stocks on the Bank.

Winter flounder courtship and spawning behavior has been described relative to estuarine habitats.

Development of a micro-constituent technique for stock identification of bluefin tuna and other species was completed.

NEFSC demonstrated that diet influences otolith micro-constituent composition in young-of-the-year bluefish.

The oceanographic conditions on the Northeast Shelf were measured and the inter-annual variability was documented in a report each year. The data were used in stock assessment activities and available to the scientific community via the World Wide Web.

NEFSC completed the second year of a sampling program in the inner New York Bight and lower Hudson-Raritan estuary studying the effects of environmental/habitat variables on settlement and early post-settlement processes of local fish species.

Bio-economic models were contributed to support fishery management decisions. These models are designed to measure and project demand conditions; evaluate direct impact of area-base management measures; and to assess other regulatory tools such as trip limits.

Reports on the level of qualitative and quantitative harvest capacity in the major fisheries of the region were completed.

Assistance in the design and evaluation of vessel buyback programs for the ground-fish fishery in the region was provided.

Biological parameters that potentially regulate foraging competition in juvenile bluefish and striped bass were identified.

A series of 30 EFH Source Documents, summarizing life history, habitat, and distribution/abundance information, was provided to NEFMC and MAFMC.

NEFSC completed a study of diets of 16 fish species in lower Hudson-Raritan Estuary, as compared to other Middle Atlantic areas.

A study of functional equivalence of marshes replanted after EXXON Bayway Oil Spill in Arthur Kill (NY/NJ) to oiled, but unrestored, marshes and control marshes was completed.

The potential predation risks of juvenile summer flounder and winter flounder in inshore habitats were quantified.

NEFSC demonstrated that nominal habitat classifications are inadequate for defining and studying the functional value of those habitats.

NEFSC has conducted studies which demonstrated that habitats are dynamic, defined by complex interactions of changing environmental conditions, and yielding a space favorable to growth and survival that continually expands, contracts, and changes position.

Environmental conditions and physical habitat within a shallow coastal nursery area in Connecticut that supports young tautog were characterized. The distribution and abundance of these fish has been described and preliminary GIS-based spatial maps have been created. Young tautog have been marked with coded wire tags in an effort, through mark-recapture, to determining individual growth rates, population size, and the extent of site-fidelity. Diets of young tautog and food habits of predators have been investigated. These efforts will be valuable in future attempts to release hatchery-reared tautog as they become available from the Milford Aquaculture Program.

The effects of egg incubation temperatures on the development and survival of summer flounder, winter flounder, windowpane, cod, and haddock have been quantified through laboratory experiments.

A study was completed that indicated that the resuspension of contaminated sediments is the dominant process in distributing contaminants in the Hudson-Raritan and Navesink estuaries.

The uptake of trace metals and organic compounds into mussels from Arthur Kill Sediments, including those tainted by oil spills, was investigated.

Research Priorities, FY 2001-2006:

I.A. Biological research concerning the abundance and life history parameters of fish stocks

- Continue to develop improved biological parameter estimates.
- Determine biological, environmental, and habitat processes controlling the reproductive success of important fishery resources.
- Expand research in the development of micro-constituent chemical analysis techniques for stock identification.

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- Continue to monitor oceanographic and biological conditions on the Northeast Shelf and document ecosystem variability in order to determine its role in the recovery and sustainability of depressed fish stocks.

I.B. Social and economic factors affecting abundance levels

- Expand sociological and economic research and incorporate results into the fishery management process.
- Develop/refine models to evaluate the efficacy of area management tools across a broad range of fisheries. This includes research into alternative approaches to resource management such as area-based resource portfolio management and the development of cooperatives.
- Investigate the impacts of latent (non-utilized) effort as stocks recover, including the design, execution, and evaluation of latent effort buyouts, and the factors affecting the reactivation and new activation of latent effort pools.
- Continue to develop guidance on National Standard 8 and on social impact assessments (SIAs). This includes examining approaches to rapid assessment techniques and institutions as well as establishing coastal cooperation in the supply of updated information relevant to SIAs on a continuing basis.
- Investigate and develop design features to mitigate perceived failures of individual fishing quota (IFQ), ITQ, and CDQ fishery regulations.

I.C. Interdependence of fisheries or stocks of fish

- Continue to investigate the importance of trophic interactions between the populations of bluefish and striped bass.

I.D. Identifying, restoring, and mapping of essential fish habitat (EFH)

- Identify and provide EFH information as required by the MSFCMA for FMPs for the NEFMC and ASMFC.
- Continue to conduct research to determine the functional value to estuarine and nearshore habitats, including restored sites, to the sustainability of fishery resources.

I.E. Impact of anthropogenic factors and environmental changes on fishpopulations

- Conduct research to determine the effects of climate variability on the sustainability of coastal and pelagic fishery resources.
- Investigate the transfer of contaminants within estuarine systems and their effect on the growth and sustainability of fish populations.

II. Conservation engineering research

Recent Accomplishments:

Through the recently established NEFSC Office of Cooperative Programs Coordination, approximately 1,600 research fishing days were conducted since the program's inception in September 2000. This multi-faceted program is designed to explore ways to improve data upon which fishery management decisions are made as well as to improve communications between fishers, scientists, and fisheries managers. One of the key elements of this program is in the area of conservation research (i.e., mesh selectivity, bycatch discard reduction, harvest efficiency, and gear development).

The NEFSC Fishery Observer Program has made recent strides in the development and deployment of more selective fishing gears by placing scientific observers aboard commercial vessels. Specifically, in the Gulf of Maine northern shrimp fishery, the Nordmore grate was tested and subsequently implemented as a method to reduce the take of juvenile groundfish. Sea sampling was used in the initial gear trials, and the at-sea observer program continues to monitor the fishery following full implementation of the grate requirement. The fishery observer data indicate significant reductions in finfish bycatch after introduction of the Nordmore grate in the shrimp fishery. Although reduced catches of important groundfishes are in part due to their decreased abundance in recent years, the grate has been effective in reducing the fraction of finfish caught in this fishery, thereby reducing fishing mortality on young groundfish.

Similar studies evaluating the effectiveness of acoustic alarms to deter harbor porpoise from entering groundfish sink gillnets have also been conducted through the Fishery Observer Program. These studies involved alarm-equipped and control nets, fished in the vicinity of harbor porpoise aggregations. Results from this work are currently being evaluated to determine the efficacy of this method in reducing harbor porpoise mortalities. Additionally, at-sea observers have been used in other gear-related studies such as in the New England groundfish fishery to evaluate the effectiveness of changes in trawl mesh size.

Three cruises were recently completed to evaluate the effect of gear on habitat by comparing fish distribution/abundance and diets, benthic communities, and sediment features in areas of Georges Bank that had been closed to fishing for five years with conditions in adjacent open areas.



Fall groundfish survey in the Gulf of Maine is conducted on R/V *Albatross IV*.

Research Priorities, FY 2001-2006:

- Conduct research to develop and enhance gear performance and characteristics.
- Conduct research aimed at reducing bycatch and marine mammal mortalities.
- Conduct studies to evaluate the effects of gears on habitats.

III. Research on the fisheries

Recent Accomplishments:

The NEFSC has recently completed development of a New England-wide Input-Output model in collaboration with the Woods Hole Oceanographic Institute's Marine Policy Center. This model is used to assess distributional impacts of fisheries regulations.

The NEFSC has conducted collateral research with the Massachusetts Institute of Technology's Center for Marine Social Sciences (CMSS). CMSS is currently collecting socio-economic data on fishers and fisheries-dependent communities. Information generated by this extensive project will be the baseline from which the social impacts of regulatory change will be measured. As a result, this project will help communities and fisheries managers anticipate potential impacts and plan accordingly.

The NEFSC has conducted Vessel Cost and Earning Surveys for all major fisheries in the region. These "snap-shot" surveys contributed to the design of the coast-wide pilot program for social science data used by the ACCSP.

The NEFSC has produced a variety of socio-economic publications on the fisheries to inform resource managers and the public. These works address such issues as property rights, allocations between recreational and commercial fisheries, rent-seeking behavior in fisheries, models of recreational fisheries, and estimates of forgone national benefits as a result of shortcomings in the management of ground-fish. Additionally, in support of two regional FMCs, the NEFSC has provided RIR/RFA analyses for 17 FMPs and numerous amendments/framework actions.

The NEFSC's Office of Marine Ecosystem Studies has been active in the monitoring and assessment of changes within the U.S. Northeast Shelf ecosystem in relation to the recovery of depleted demersal fish stocks, including cod, haddock, and yellowtail flounder and the unprecedented population explosion of pelagic herring and mackerel stocks.

Several United Nations agencies are collaborating with the NMFS Office of Science and Technology and Fishery Centers to introduce ecosystem-based assessment and management practices leading to the recovery of depleted fish stocks in

Asia, Africa, Latin America, and eastern Europe. A five module strategic approach developed and tested by the NEFSC has been introduced to coastal countries bordering LMEs of the Yellow Sea (China and Korea), the Benguela Current (Angola, Namibia, South Africa), the Guinea Current (Benin, Cameroon, Ghana, Ivory Coast, Nigeria, and Togo), and Baltic Sea (Denmark, Finland, Germany, Sweden, Estonia, Latvia, Lithuania, Poland, and Russia). The five modules provide advanced methodologies for monitoring and assessing the: (1) productivity, (2) fish and fisheries, (3) pollution and health, (4) socio-economics, and (5) governance of the LMEs.

Grants from the Global Environment Facility have been allocated over the past five years to support the LME projects. In each of the LME projects, joint international surveys are carried out measuring the effects of changing ecosystem states on the recovery of depleted fish stocks and the long term sustainability of biomass yields, ecosystem health, and socio-economic benefits to the coastal communities. Participating countries have created, under UNCLOS, Commissions and other joint institutions to serve as governance bodies and to initiate more sustainable ecosystem-based management protocols than have been generally initiated and practiced during the past half century.

Tautog have been cultured successfully from egg to about 1-1.5 lbs, a size especially desired for the live-market trade. Egg hatching rates are high, but the larvae are extremely sensitive to handling. Research efforts have focused on culture techniques that involved little or no handling of these sensitive early stages. Once fish reach the juvenile stage, survival rates are high. Optimum diets are being developed.

An integrated, micro-algal, shellfish nursery/wastewater treatment system was designed, built, and tested. This land-based, pilot-scale nursery for production of molluscan shellfish seed was based upon seawater recirculation technology. This innovation in scientific and engineering accomplishments represents an important step in developing sustainable and environmentally-compatible shellfish aquaculture in the U.S. and throughout the world.

A manuscript was published describing several years of field research that investigated different strategies to enhance the bay scallop population in a shallow coastal estuary in Connecticut. Part of the project was a collaboration with volunteers from a local Shellfish Commission. Low dissolved oxygen concentrations were found within some eelgrass beds during midsummer, but environmental conditions were generally favorable to support scallop growth. It was determined that natural recruitment was too low to support spat collection-based enhancement efforts. A transplant of large seed scallops in late fall resulted in a spawning stock that released new larvae into the estuary the following year. Use of suspension culture gear to rear, overwinter, and provide spawner sanctuaries was also demonstrated.

The first biochemically-based feeding standards for molluscan shellfish seed were developed. Using a custom designed and built computer-controlled feeding apparatus, NEFSC scientists determined both qualitative and quantitative nutritional needs of bay-scallop seed for optimal growth and feed-conversion efficiency. Feed-

ing standards, analogous to those used routinely in animal agriculture, were developed for molluscan shellfish for the first time, marking a milestone in the development of shellfish aquaculture.

Research Priorities, FY 2001-2006:

III.A. Social and economic research

- Continue the development of ongoing coast-wide cost and earnings data collection systems. This research includes the design of a fixed cost sampling protocol and the exploration of wide-scale observer-supplied economic data systems.
- Continue the development of a socio-cultural information gathering system sufficient for National Environmental Policy Act, National Standard 8, and SIA requirements for fisheries, marine mammals, endangered species, critical habitat for designated species, and EFH designations.
- Conduct additional research into multi-species management options incorporating various levels of constituent species. Research will focus on differential area treatment of gears, vessels, and effort based on habitat and fishing mortality considerations as well as impacts of variously defined MPAs.
- Conduct further exploration of applicability and utility of GIS information on economic and socio-cultural assessments of area-based management options including development of socio-economic and governance modules for LMEs.
- Continue research efforts for price models, bio-economic models, rapid social assessments techniques, rights-based fishing modes, annual round fisheries, and other issues central to improving approaches to management and the design and assessment of alternatives. Of particular concern is the coming need for the estimation of non-use benefits and cost minimization research for EFH, ESA, and MMPA issues.
- Extend input-output models to mid-Atlantic states for the management of recreational fisheries. This expansion includes: (1) analysis of effort and participation in specific recreational fisheries to better assess impacts of regulations on recreational fishers; (2) development of participation models to predict levels of activity 5-10 years into the future; and (3) defining and exploring recreational/subsistence fishing communities and their dependency and vulnerability to standard management alternatives.

III.C. Marine aquaculture

- Continue to conduct Aquaculture and Enhancement Division activities.

IV. Information management research

Recent Accomplishments:

NEFSC oceanographic data sets are being served through a distributed oceanographic data system (DODS) compliant server. In addition, data collected as part of the U.S. GLOBEC program on Georges Bank are being served through the GLOBEC data system, which is a DODS compliant system.

Research Priorities, FY 2001-2006:

- Continue to develop and expand DODS compliant client and server libraries to support Internet access to NODC oceanographic data sets.