

NATIONAL MARINE FISHERIES SERVICE

**STRATEGIC PLAN
FOR FISHERIES RESEARCH**

FEBRUARY 1998



U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

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NATIONAL MARINE FISHERIES SERVICE

MISSION STATEMENT

***Stewardship of living marine
resources for the benefit of the
Nation through their science-based
conservation and management and
promotion of the health of their
environment.***

(NOAA Fisheries Strategic Plan -- May 1997)

PREFACE

The National Marine Fisheries Service (NMFS) is the agency responsible for the science-based conservation and management of the Nation's living marine resources. NMFS is part of the National Oceanic and Atmospheric Administration (NOAA) within the Department of Commerce. NMFS scientists collect and analyze scientific data on the Nation's living marine resources, marine ecosystems, and the benefits they provide to the Nation. The agency uses these data to prepare scientific reports and technical presentations to fishery managers, industry and environmental groups, and the public, as well as the scientific community. These reports are NMFS' foundation for developing sound policies governing the use and conservation of living marine resources and protecting their habitat.

In 1993, NOAA developed an agency-wide Strategic Plan which focused on a ten-year vision of how NOAA could contribute to the goal of bringing scientific information to bear on key societal decisions. A year later a science review process was initiated to look at the quality of the research, the methodological approaches, the relevancy and adequacy of the science activities, and the strength and value of partnerships among NOAA's programs with outside groups. This strategic research plan for meeting the requirements of the Sustainable Fisheries Act is consistent with the conclusions of the NOAA science review.

In 1997, NMFS published a *Strategic Plan for NOAA Fisheries*. The Plan had been developed in a comprehensive manner, with extraordinary public involvement, including 16 public meetings. The present Sustainable Fisheries Act Strategic Plan for Research is entirely consistent with the NMFS Strategic Plan. It is a subset of the all encompassing NMFS Plan. The objectives found under the "Major Fishery Research Goals and Objectives" section of this document can be matched with strategies in the NMFS Strategic Plan.

The scope of the present document includes fisheries, habitat, protected species, and utilization research to address requirements of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) only. It does not include the regulatory and enforcement components of the NMFS mission. NMFS currently conducts a very comprehensive program of fisheries research, and involves industry and others interested in fisheries planning and operations. However, there is always room for improvement. This plan covers what we do now and how we expect to improve it. It relies primarily on the current NMFS budget and strives to maximize benefits.

**NATIONAL MARINE FISHERIES SERVICE
STRATEGIC PLAN FOR FISHERIES RESEARCH
FOR MEETING REQUIREMENTS OF
THE SUSTAINABLE FISHERIES ACT OF 1996**

LEGISLATIVE BACKGROUND

The United States Congress reauthorized the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), as amended by the Sustainable Fisheries Act (SFA), on October 11, 1996. Section 404 (Fisheries Research) of the MSFCMA requires the Secretary of Commerce to develop and publish in the Federal Register a strategic plan for fisheries research for the five (5) years immediately following such publication. The Act stipulates that the plan:

- Identify and describe a comprehensive program with a limited number of priority objectives for research in each of the research areas specified below.
- Indicate goals and timetables for the program.
- Provide a role for commercial fishers in such research, including involvement in field testing.
- Provide for collection and dissemination, in a timely manner, of complete and accurate information concerning fishing activities, catch, effort, stock assessments, and other research conducted under this section.
- Be developed in cooperation with the Fishery Management Councils and affected states, and provide for coordination with the Councils, affected states, and other research entities.

The MSFCMA requires that the comprehensive program contain the following areas of research:

- Research to support fishery conservation and management, including but not limited to:
 - biological research concerning the abundance and life history parameters of stocks of fish,
 - the interdependence of fisheries or stocks of fish,
 - the identification of essential fish habitat,

- the impact of pollution on fish populations,
 - the impact of wetland and estuarine degradation, and
 - other factors affecting the abundance and availability of fish.
- Conservation engineering research, including:
 - the study of fish behavior,
 - the development and testing of new gear technology and fishing techniques to minimize bycatch and any adverse effects on essential fish habitat, and
 - promote efficient harvest of target species.
- Research on the fisheries, including:
 - the social, cultural, and economic relationships among fishing vessel owners, crew, fish processors, associated shoreside labor, seafood markets, and fishing communities,
- Information management research, including:
 - the development of a fishery information base and an information management system under Section 401 that will permit the full use of information in the support of effective fishery conservation and management.

COMPREHENSIVE FISHERY RESEARCH PROGRAM

Research Components

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) mandates strong action to protect fishery resources that contribute to the food supply, economy, and health of the Nation. MSFCMA provisions require NMFS to end overfishing, rebuild all overfished stocks, and conserve essential fish habitat through research and consultations on Federal and state actions which may adversely affect such habitat. These are among our primary stewardship responsibilities.

NMFS is responsible for ensuring that management decisions are based on the highest quality scientific information on the biological, social, and economic status of the fisheries. Biologically, this includes species' responses to environmental changes, exploitation, and other human activities that affect them and their habitat. This includes social, cultural, and economic beliefs and incentives which influence human/marine interactions. All of the agency's information must be comprehensive, objective, credible, and effectively communicated. It is used not just for current management decisions, but also to conserve resources and anticipate future trends, assure future utilization opportunities, and assess the success or failure of the agency's management efforts.

NMFS is also responsible for ensuring that this information, and thus the management decisions for which it provides the foundation, is understood and its validity accepted by user groups and other constituents. To accomplish this, the Magnuson-Stevens Fishery Conservation and Management Act has mandated that we provide a role for commercial fishers in our fisheries research.

The research priorities of NMFS may be grouped into the four major areas with several sub-areas defined by Congress (see Legislative Background):

- I. Research to support fishery conservation and management**
- II. Conservation engineering research**
- III. Research on the fisheries**
- IV. Information management research**

I. Research to Support Fishery Conservation and Management

Living marine resources currently support extensive commercial, recreational, and subsistence uses. In 1996, commercial landings by U.S. fishers were 9.6 billion pounds valued at \$3.5 billion. The 1996 U.S. marine recreational fish catch was an estimated 313 million fish taken on an estimated 64 million fishing trips. These represent just some of the many benefits Americans derive from living marine resources.

However, many marine species are under stress from overexploitation or habitat degradation, or both. Over one-third of all fish stocks for which we have scientific population information are overutilized, and nearly half are below optimal population levels. Some populations are in danger of extinction, and many more are threatened by various human activities. There are many other species about which we have little information. Many factors, both natural and human-related, affect the status of fish stocks and their environment. NMFS scientists are actively engaged in collaborative research to protect and enhance fishery resources. These research efforts include mapping, spatial analyses, geographic information systems (GIS), and fishery and ocean habitat modeling and characterization, as well as an evaluation of ecosystem approaches focusing on spatially-explicit models and additional research into trophic relationships. Additionally, with the increasing need to seek new management approaches to minimize and conserve essential fish habitat (EFH), NMFS is conducting studies on adaptive/management techniques through the identification and use of potential areas of refugia (i.e., research closure areas) and experiments on no-take and limited take zones and time-area closures.

NMFS' research efforts incorporate the use of innovative new technologies and techniques. For example, NMFS in cooperation with NOAA is developing innovative new technology to enhance survey capabilities with research and development on an omnidirectional hydroacoustic system to combine biomass assessments with the ability to acoustically identify species, utilizing airborne LIDAR (Light Detection And Ranging Laser) technology as a biomass assessment tool for near-surface pelagic species, and using underwater (laserline) technology for identification of habitat types and species identification.

It is NMFS' responsibility to provide fishery managers with the information needed to make scientifically sound decisions. In order to support fishery conservation and management, NMFS scientists are actively pursuing the following areas of research.

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

Research in this area includes collecting information on catch and effort, and on biostatistical characteristics, for a variety of Fishery Management Plan (FMP) and non-FMP species of exploited fish and shellfish. Fishery-dependent and fishery independent sources provide information including age and size samples from fish landed, plant and vessel specific

landings records, and other plant/fleet data. These data are key inputs to stock assessments, fishery management regulations, and the production of Federal economic and resource statistical summarizations.

The actual level of complexity of an assessment is determined by the amount of information available and by the amount of information needed by management. Although there is some overlap, assessments can be roughly grouped in order of increasing level of complexity into the following categories, each one including features of all simpler levels.

Kinds of Assessments

- **INDEX:** assessment relies on “trends”, index of stock size from resource survey data or from fishery catch-per-unit-of-effort (CPUE) data, mean size, landings, and age composition.
- **YIELD:** assessment also includes an evaluation of yield tradeoffs for different levels of fishing mortality and ages of fish caught, (e.g., yield-per-recruit analysis).
- **AGE STRUCTURE:** assessment also includes analysis of the observed age composition of the catch and surveys (e.g., virtual population analysis).
- **SPAWNING STOCK:** assessment also includes analysis of data on spawning stock size and subsequent recruitment of juveniles and subadults and ratios of unfished to fished reproductive potential of stocks.
- **PREDICTIVE:** assessment also includes a model for future stock conditions that accounts for variations in the environment and future recruitment and exploitation rates.

Understanding aspects of the life history of fish stocks will be of increasing importance in the management of the Nation’s living marine resources. Describing migratory and distribution patterns, habitat use, age, growth, mortality, age structure, sex ratios, and reproductive biology will be essential information for scientists and managers to optimize sustainability and yield of these resources. A variety of methods will be employed, including otolith aging, histological analyses of gonads, and observations of spawning behavior for species with complex reproductive systems. Studies of early life history and fishery oceanography are necessary to understand recruitment dynamics and lead to prediction of year-class strength. There is an increasing need to identify and characterize discrete stocks. This will allow scientists and managers to correctly structure stock assessments and design stock specific management measures for groundfish complexes, salmon species, coastal migratory and oceanic migratory species and reef fish. Stock identification involves many techniques, including mark-recapture, otolith shape analysis, parasite distributions, and biochemical genetic methods.

I.B. Social and economic factors affecting abundance levels

NMFS also recognizes the social, cultural, and economic diversity of the fisheries, and the importance of recognizing those differences in creating effective conservation measures. For

instance, one critical factor affecting stock abundance is the level of fishing effort. Type and location of both commercial and recreational fishing effort vary across different fishing fleets, groups of anglers, and communities. Also, these groups will differ in their responses to alternative strategies of effort control such as days-at-sea, closed areas, limited access, and bag-limits. NMFS will need new data and models, and modifications to existing models, to capture fully this diversity and its interaction with biological diversity.

NMFS will therefore develop bio-socio-economic models and increase collection of data necessary to meet conservation goals and maximize net economic and social benefits to the Nation from living marine resources. For commercial fishing, these data include: vessel and plant level cost and earnings data; ex-vessel prices; and data on social and institutional constraints such as open access regimes or differing ethnicity-based labor practices. For recreational and subsistence fishing, these data include: information on expenditures, trip characteristics, demographic descriptors, and social and cultural influences on fishing behavior. Given that some of these data are newly emphasized, national coordination and funding of these activities will be especially important.

Coordinated bio-socio-economic research and analysis will add the element of human variability to stock variability, thus bringing the parameters of our models closer to real world conditions. This, in turn, will make stock assessments more predictive and facilitate a precautionary approach.

I.C. Interdependence of fisheries or stocks of fish

Interdependence characterizes an ecosystem. Ecosystem interdependence means that living and non-living parts of an ecosystem are linked to each other - for example by food chains. This information is very important if we are to successfully manage our living marine resources. The health of a fish stock and the merits of alternative harvest strategies cannot be determined in isolation; an ecosystem approach is needed to take into account the various factors that affect the status of a stock and the importance of a stock to other components of the ecosystem. The abundance of a fish stock depends on a number of factors, including the abundance and health of its competitors, predators, and prey, as well as its symbiotic relationships. Elimination and/or reduction in quality of habitat that is essential to a prey can have as great an impact as destroying the habitat of the targeted species. The chief objective of the biological studies on ecosystem interdependence is to determine consumption rates and the functional form of feeding interrelationships of fish, and to develop recruitment and multispecies models which incorporate this information. The developed models are used to help predict long-term impacts of various harvest strategies and environmental trends on yield potential and species composition. Results are incorporated into recruitment and multispecies models to investigate effects of predation and compensatory population mechanisms on long-term stability, production, and structure of fish communities under

different harvest strategies and environmental regimes. Research activities include the following:

- NMFS investigates marine food webs through field and laboratory studies of fish consumption rates and feeding selectivity patterns using state-of-the-art technologies.
- Food web studies are conducted in both laboratory and field experiments to determine food preference and nutritional values of various foods.
- Studies are conducted to determine density-dependent, predator-prey interactions. The studies are of particular importance since these interactions affect the stock/recruitment relationships which are critical to understanding long-term dynamics of fish populations.
- Fish stomach contents are sampled and analyzed. Samples are studied together with hydroacoustic and bottom trawl surveys to relate predator densities with larval and early juvenile fish densities, in order to quantify predation mortality.
- NMFS examines diet, consumption rates, and prey for major pelagic and demersal fishes.
- NMFS ascertains predator species guilds (species assemblages with similar diet and habits) based on food habits data.

To examine human activities in an ecosystem perspective, research is required on fishing patterns. Some fishers target a single species or species assemblage exclusively. Others fish for a variety of different species by season (an annual round), sometimes switching gears to do so. Yet other fishers are part-time participants only, working in land-based occupations for some portion of the year. Fishers using certain gear types and vessel sizes appear more likely to adopt one pattern over another. These different patterns imply different levels and types of effort and have differing effects on their various target species, and are therefore important to ecosystem management. Some critical research areas include:

- The suite of fishing and non-fishing activities both available to commercial fishers and for which they are qualified.
- The geographic range within which various fleets operate.
- The annual rounds of fishing activity by various fleets, and the flexibility of those rounds.
- The amount and importance of subsistence, recreational, and part-time fishing.

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

The long-term viability of living marine resources depends on protection of their habitat. The effects of habitat degradation are often insidious, and some losses are not well understood. Others, however, are apparent. We know, for example, that dams for hydroelectric power generation and water diversion for agriculture have severely reduced some valuable anadromous fish runs, and chemical contaminants cause neoplasms in fish

(e.g., winter flounder in Boston Harbor and English sole in Puget Sound). We also know that habitat changes in Florida Bay and Chesapeake Bay have resulted in continual changes in fish communities.

The Sustainable Fisheries Act of 1996 requires Fishery Management Councils (FMCs) to describe and identify EFH in FMPs and minimize adverse impacts on such habitat. It also requires that the Secretary of Commerce initiate and maintain research to identify EFH, the impact of wetland and estuarine degradation, and other factors affecting the abundance and availability of fish. MSFMCA defines EFH as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of EFH: ‘waters’ includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include aquatic areas historically used by fish where appropriate; ‘substrate’ includes sediment, hard bottom, structures underlying the waters, and associated biological communities; ‘necessary’ means the habitat required to support a sustainable fishery and the managed species’ contribution to a healthy ecosystem; and ‘spawning, breeding, feeding, or growth to maturity’ covers a species’ full life cycle.”¹

NMFS will continue to conduct research, analyze data, and provide consultation necessary to: (1) identify estuarine, coastal, and oceanic habitats and their utilization by various life stages of living marine resources (LMRs) for spawning, growth, and protection, through comparative studies of similar habitats in stressed and unstressed environs as well as comparative studies of different habitats; (2) document the life history of managed fish and determine factors that influence resiliency or sensitivity to fishing; (3) increase NMFS’ understanding of the role of the benthic community in the overall ecosystem, the interaction of target fish with benthic communities, and effects of fishing on benthic communities; (4) determine the best methods for restoring LMRs injured by human impacts including harmful spills, vessel groundings, material disposal, and fishing; (5) develop population and habitat recovery models; (6) describe seasonal changes in hydrographic nearshore waters, megainvertebrates, and benthic infaunal communities in estuaries and nearshore waters; (7) map EFH using remote sensing platforms (satellite, aerial, and acoustic) along with ground truth and algorithm development to assess habitat type and quality and environmental parameters such as temperature, turbidity and salinity; (8) work cooperatively with fishers to gain information on current habitat configurations; (9) research the social and economic impacts of specific habitat protection proposals; (10) assess current social and economic

¹Magnuson-Stevens Act Provisions; Essential Fish Habitat, Interim Final Rule, Federal Register, Vol. 62, No. 244/Friday, December 19, 1997.

value of EFH; and (11) research social and economic causes of habitat degradation. The information resulting from these activities will be used by fishery managers to identify, describe, conserve, and enhance EFH. The NMFS Centers staff work closely with Regional Offices, FMCs, and the NOAA Damage Assessment and Restoration Program to provide timely habitat information. NMFS works with the NOAA line offices and other agencies in developing the Coastal Change Analysis Program (C-CAP) and Coastwatch to apply satellite imagery and aerial photography to habitat mapping, analysis of change in coastal land cover, and assessment of water temperature, color, and circulation.

These research areas and the specific EFH research described for each Fishery Science Center will be used by NMFS and the fishery management councils to:

- Develop a comprehensive and coordinated base-funded habitat research program in NMFS that interacts with and provides information to habitat managers and the Offices of Science and Technology, Sustainable Fisheries, Habitat Conservation, and Protected Resources.
- Improve understanding of the distribution and habitat requirements of early life stages of managed species.
- Improve stock assessment capabilities and reduce uncertainty.
- Improve habitat protection capabilities and improve assessment of threats to EFH and managed fishery stocks.
- Synthesize research information needs nationally and prioritize habitat research and funding across regions to permit refinement of EFH identification as required by the MSFCMA.
- Develop a synthesis of existing data to identify EFH based on the regulatory four-tiered approach for each region.
- Develop a national database on habitat restoration measures and designs that enhance recovery of biodiversity and value to fisheries.
- Map EFH for managed species in each region, and develop a national GIS database on essential habitat.
- Restore degraded habitat.
- Cooperate with fishers in gathering information on habitat.
- Assess relative economic and social impacts of different habitat restoration measures and designs.
- Research current incentives for habitat protection, including literature reviews of incentives for non-fishery activities such as land-based non-point-source pollution.

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

There is a recognition in the scientific community that toxic contaminant discharges to the coastal oceans can have a significant impact on the viability of important fish populations. Contaminants can disrupt an organism's early life stage development and growth that in turn can affect their reproductive potential as adults. Such nonlethal effects are not easily

identified or characterized, and therefore, are difficult to relate to the sustainability of the fishery populations. The quantification and identification of deleterious changes is further complicated by natural and uncontrolled variability within and between fishery populations and their supporting food webs. NMFS will continue to study the potential effects of contaminants on important fishery species as well as the sources of variability. To assess the risk to fish populations from different combinations of stressors there must be a linkage made between understanding toxic effects of contaminants to individual organisms and the factors, both anthropogenic and natural, that influence fishery populations. There has been growing recognition that marine pollution can disrupt the development and function of the reproductive, endocrine, immune, and nervous systems of marine animals, including fishes, affecting reproductive and growth processes critical to population stability. Early life stages are the most sensitive to these pollutants, and the effects can be irreversible. Because the effects are not always immediately visible, it is difficult to establish the impact on fish populations. Environmental variables and natural variations further complicate the picture. NMFS will continue to study similar habitats in stressed and unstressed anadromous streams, estuarine, and ocean environs in order to understand the effects of pollution on LMRs and their habitats. NMFS will also research social and economic causes of habitat degradation, from fishery and non-fishery sources, including coordination with researchers studying land-based activities such as non-point source pollution and urban development. NMFS also engages in research to determine the effects of long-term changes in the ocean climate on LMRs. This information helps assess the true impact of human-induced factors.

Habitat loss and degradation affects riverine, estuarine, and coastal ecosystems. The primary threats come from physical destruction of wetland and other habitats, alteration of freshwater flows, eutrophication, and destructive fishing methods. For example, logging contributes to siltation and can destroy salmon spawning habitat upriver and impede their migratory paths. Construction of marinas and docking facilities as well as dredging and the disposal of dredged material in estuaries and bays also cause significant habitat impacts. Loss of aquatic habitat (e.g., coastal wetlands or seagrass and kelp beds) resulting from development adversely affects a variety of food webs that are important to adults and juveniles of many marine and anadromous species. Propeller damage to shallow vegetated and non-vegetated habitats not only causes a direct loss of habitat, but results in destabilization of these areas, resulting in increased habitat loss and increased sediment re-suspension and turbidity. Diminution in freshwater volume and flow rates stem from damming and diversions of major rivers impacting nearshore ecosystems adapted to seasonal discharges of freshwater. Destructive fishing methods can damage EFH and coral reefs. In the past, extremely damaging fishing practices that employed explosives or poisons were prevalent in some Pacific and Caribbean islands. These are now almost universally outlawed, but poaching by these methods remains a problem in remote regions of the western Pacific islands.

Nutrient enrichment and eutrophication have a major impact on fish populations in estuarine and coastal waters. This impact is manifested by hypoxia/anoxia accompanying the death of phytoplankton populations (Gulf of Mexico dead zone off of the Mississippi River and western Long Island Sound) and loss of inshore habitat (replacement of eelgrass beds by macroalgae or loss of eelgrass beds due to shading by epiphytes or phytoplankton - Chesapeake Bay, Waiquiot Bay, Lake Pontchartrain).

NMFS will engage in a variety of research initiatives to study the effects of natural and man-made environmental changes on living marine resources and the related ecosystem, social, and economic causes and effects, including:

- Determination of the cumulative effects of watershed and regional land cover and changes in that land cover on EFH.
- Ecosystem monitoring for habitat degradation and resource surveys by satellite remote sensing and shipboard and moored instrumentation.
- Development of rationales/methodologies to detect and quantify habitat loss.
- Establishment of a GIS database to document and track habitat loss.
- Development of methodologies to detect and quantify the effects of habitat alterations on fishery populations.
- Laboratory and field research to identify the probable results of contaminant inputs and habitat alterations that significantly affect important fishery species.
- Development of molecular genetic techniques to assess the fitness of fishery organisms.
- Development of models (descriptive and predictive) to assess the risk posed by contaminants and habitat alterations to fishery populations.
- Analysis and synthesis of existing environmental and fishery data that are available on fishery habitat types and fishery populations.
- Cooperation with fishers in assessing habitat changes over the past decade.
- Assessment of current economic and social incentives for habitat protection or degradation.

II. Conservation Engineering Research

Conservation engineering research is intended to make fishing gear more efficient by decreasing fishing costs, bycatch mortality, and habitat destruction. It is also intended to improve the data provided by scientific surveys of fish populations. This area includes research on gear performance and fish behavior used in the development of selective fishing gear to reduce bycatch. Bycatch is responsible for the death of millions of juvenile finfish, including red drum, red snapper, weakfish, Spanish mackerel, and king mackerel. It is estimated that 38 million red snapper are discarded per year. The Food and Agriculture Organization (FAO) estimates that one-third of the world's 16 billion lbs. of bycatch comes from shrimp fishing. The most recent studies of bycatch estimate that the ratio of bycatch to

shrimp landed is between 3:1 to 4:1, although older studies documented a 10:1 bycatch to catch ratio. The worldwide bycatch ratio for all fisheries is 0.35 lb to 1 lb. of target species.

Since few discarded fish survive, bycatch constitutes a problem for fishery managers because it represents both an unaccounted mortality in fisheries and an economic loss to harvesters and the Nation. For instance, fishers in another fishery might target the discarded species, or fishers in the same fishery might be able to keep those same fish when they are older or larger. Recreational discards are another source of fishing mortality. Information is needed to determine proportions of discards in different recreational fisheries and assess associated release mortality. Additionally, NMFS will encourage research on ways to increase the survival of recreational releases. Bycatch reduction, then, is critical for the continued existence of healthy fisheries, and is especially critical when the bycatch includes protected species. NMFS conducts research at several of its laboratories on populations of ESA-listed and marine mammals. Stocks of listed species and marine mammals have interactions, primarily as bycatch, with species managed under the MSFCMA. As such, research conducted to support requirements of the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA) also make an important contribution to supporting conservation and management requirements of the MSFCMA. Along with incentives and other management strategies, one solution to bycatch reduction lies with the design and operation of selective fishing gears that encompass knowledge of species behavior, gear hydrodynamics, and fishing practices.

Bycatch levels and control measures continue to occupy the attention of most fishery management actions of all regional FMCs. Even when apparent solutions are found, the dynamics and abundance of marine species change in time and area, which can shift the character of the problems and require continuous adjustments to their solutions. NMFS will continue to conduct studies to determine the magnitude of bycatch of overfished stocks, and options to reduce it. The options may require the design of new types of fishing gear that are more selective for the targeted species. This approach is known as “conservation engineering” and NMFS will work in cooperation with the fishing industry and gear manufacturers to find designs that meet conservation needs while recognizing the financial constraints of fishermen.

To determine when gear modifications are the most appropriate response to bycatch problems, NMFS will study existing programs such as the Turtle Excluder Devices (TEDs) in the Gulf of Mexico and Bycatch Reduction Devices (BRDs) to exclude finfish from Gulf shrimp trawls and from Northern shrimp trawls in New England. By understanding the successes and setbacks in these and other settings, NMFS will be better able to coordinate gear research with the social, economic, and institutional constraints of specific fisheries.

Experimental work with selective fishing gear involves considerable field work on board fishing vessels working under actual fishing conditions. Most trawl gear evaluation includes an alternate tow approach, varying which net is fishing with the experimental gear and comparing the catch results using statistical tests. Underwater cameras allow for examination of the behavioral mechanisms and gear variations that would account for the catch differences.

Growing controversy over the impact fishing gear is having on EFH has resulted in a need to evaluate the impacts. Effects from fishing may include physical disturbance of the substrate, and loss of and injury to, benthic organisms, prey species and their habitat, and other components of the ecosystem. Experiments are being designed to assess the potential effects of all fishing gear types used in waters described as EFH. These studies will include the use of remote underwater cameras, divers, abundance studies, and perhaps research closure areas for comparison. If an adverse effect is identified and determined to be an impediment to reaching target long-term production levels, then the research needed to quantify and mitigate that effect would be the next logical step.

Growing concern over the impacts of bycatch on stocks resulted in the development of a NMFS Bycatch Plan which is available for request or through NMFS website (<http://kingfish.ssp.nmfs.gov/bycatch>). This plan was compiled by agency experts with experience in fishery management, stock assessment and social sciences. It includes proposed national bycatch objectives, specific recommendations concerning data collection, evaluation and management actions necessary to attain the objectives, and a comprehensive assessment of the state of bycatch in the Nation's marine fisheries. The latter is intended to serve as a benchmark from which progress in bycatch reduction can be measured.

The NMFS is committed to maximizing the research contribution of the fishing industry and other non-government participants in the fisheries. Across the NMFS Regions, the industry is providing advice in research planning, in formal reviews of research programs, and where possible, in research operations. Examples of research involvement includes: (1) provision of chartered vessels and crew for surveys and bycatch gear development, (2) keeping logbooks of species catches - including bycatch, and (3) industry efforts to develop gear, gear modifications, and fishing practices to reduce bycatch.

The Saltonstall-Kennedy Program has had direct industry involvement and investment since its inception decades ago. Industry members submit proposals, usually with strong cost sharing, to conduct research in conservation engineering, development of fisheries for underutilized species to relieve pressure on traditional species, and to improve the after-catch utilization of nearly all species.

III. Research on the Fisheries

In 1993, of the 163 U.S. fisheries whose biological status could be assessed, 40% were classified as overutilized and 43% were fully utilized. Drastic measures have been implemented to halt the decline in stock levels in some of these fisheries. Causes typically cited for the declines include overfishing, deteriorating environmental conditions, loss of habitat, and changing oceanographic conditions. Those fisheries that are considered biologically healthy, such as Alaska pollock and other Alaska groundfish are harvested at high levels. However, the high levels are achieved by increasingly more and larger vessels fishing during shorter and shorter seasons. These inefficiencies result in tremendous economic costs to the Nation.

III.A. Social and economic research

Social and economic information has become increasingly important in addressing fishery conservation and management issues. Federal law and NMFS policy require social and economic assessments of proposed regulatory or policy changes. The U.S. fishing fleet, however, is quite diverse in terms of sizes and gear types. Vessel sizes and types vary significantly between fisheries as well as between geographic areas. One consequence of the size and diversity of the harvest sector is that management of all U.S. fisheries with a single policy is not feasible. Even individual fleets are quite diverse, and each fishery has unique biological, economic, and sociological characteristics that make broad-based policy impractical. For example, vessel sizes, gear types, crew sizes, and processing, marketing and distributional arrangements vary significantly among fisheries and geographic areas. Educational levels, household dependence on fishing, preferred target species and fishing patterns differ across fisheries and fishing communities. Levels and types of social, cultural and economic dependence on fisheries vary by community and region. Management decisions must reflect the needs of many different groups, including commercial and recreational fishers, subsistence fishing communities, non-consumptive users, Pacific Islanders, and Native American tribes, many of which have treaties with the United States guaranteeing certain fishing rights. NMFS must consider efficiency, minimize costs, avoid unnecessary waste and duplication, and allocate harvest restrictions and recovery benefits fairly among all users, while minimizing adverse economic impacts on fishing communities, as consistent with our conservation objectives. Adequate consideration of these factors requires that NMFS have available to it sufficient background information about fishing communities for adequate social and economic impact assessments.

To achieve this, models will require new data on a number of sectors, including the following:

- The U.S. commercial harvesting sector - Detailed social and economic analyses of the majority of U.S. fisheries will be conducted to determine current social and economic

costs and benefits in the harvest of living marine resources, and determine methods to maximize net benefits through innovative management alternatives.

- The U.S. seafood processing/wholesale sector - The processing and wholesale sectors are an integral part of the seafood industry. As in the harvesting sector, technological innovations advance the processing and distribution of seafood. NMFS will continue to collect annual data to determine the total number of processing and wholesaling plants, the number of people employed, and the total volume and value processed. NMFS will also develop econometric models of the processing sector, determine the effect of common property resources on capital investment, and increase research on social and economic relationships among processors and wholesalers, and between these and harvesters, in order to better understand the cultural and other institutional influences on the structure of seafood markets.
- The U.S. trade sector - The U.S. plays a major role in the international seafood market, importing and exporting billions of dollars worth of seafood each year. The U.S. seafood trade market in part reflects conditions in its domestic fisheries. NMFS will conduct an annual survey to determine our share of the international seafood trade market, and determine how trade agreements impact our Nation's competitiveness in this arena.
- Retail demand for seafood - Social and economic forces in the United States over time have influenced the current makeup of the seafood industry. Population, real per capita income and the prices of substitutes are three factors that economic theory suggests should explain the aggregate demand for seafood. NMFS will conduct studies to gain a greater understanding of the responsiveness of consumers to changes in prices and quality, their willingness to substitute among various seafood products and other protein sources, their readiness to purchase imported products, and the responsiveness of fish and fishery product prices to changes in harvest levels.
- The U.S. recreational harvesting sector - The recreational and commercial fishing sectors are interdependent and have much in common. Policies aimed at regulating one group almost always impact the other and often affect other sectors of the marine fishing industry. NMFS will assess the net economic and social benefits from various allocation scenarios using estimation of anglers' consumer surplus, commercial fishers' producer surplus, and, theoretically, the consumer surplus for commercial catch as well.
- U.S. commercial fisheries - NMFS will conduct empirical research using both qualitative and quantitative techniques of the fisheries, including vessel owners, crew, U.S. fish processors, associated shoreside employment, and fishing communities to model and assess social, cultural, and economic factors related to community dependence on fisheries.
- The U.S. recreational fisheries - NMFS will conduct empirical research using both qualitative and quantitative techniques of the fisheries, including fishermen, fishery support sector, associated shoreside fishery employment, and fishing communities to

model and assess social, cultural, and economic factors related to community dependence on the fishery.

- U.S. subsistence and traditional use fisheries - NMFS will conduct empirical research using both qualitative and quantitative techniques of the fisheries, including alternative sources of protein and cultural and ritual uses of the harvested living marine resources to model and assess social, cultural, and economic factors related to community dependence on the fishery.
- Fishing communities - NMFS will collect or acquire from other sources qualitative ethnographic, demographic, and economic data important for the social and economic profiling of fishing communities, including opportunity costs, social structure, and ethnohistorical data, and other data needed for input-output models and analyses of distributional effects of alternative management policies.
- Economic impact analyses - NMFS will collect or acquire from other sources the cost and earning data necessary for Regulatory Impact Review (RIR) and Initial Regulatory Flexibility Analysis (IRFA) studies.
- Social impact assessment - NMFS will collect or acquire from other sources ethnographic data related to fishing decision-making processes of captains; investment decision-making processes of owners; information flows within the fishery; and the differential effects of management policies on various subsets of the fishing industry such as absentee owners, captain-owners, and crew members, full-time and part-time fishers, fishers with different household compositions, large vessels and the undertonnage fleet, those who target single species or complexes, and those who fish different gears and species by season.
- Overcapacity - Assess current levels of capacity of U.S. commercial fleets (including charter/party vessels), determine optimal levels, and develop approaches to solving the problem of over-capitalization.

III.B. Full utilization of harvested fish

The ultimate destination of harvested and processed fish, not used for feed and fertilizer, is the seafood consumer. Consumer demand essentially drives the fishing industry; consumers' preferences and their willingness to pay for fish are major determinants of which species are caught and sold in the marketplace. The preferences for seafood have been changing over time. Changes in technology in the harvest and processing sectors have increased the availability of fresh and frozen seafood to consumers. One obstacle to increased utilization of harvested fish is consumer concern over seafood safety. It is thus especially important to determine how best to minimize consumer risk from seafood consumption and to determine potential losses in consumer surplus due to contaminated seafood (e.g., from toxins, oil spills or outbreaks of diseases in harvest areas).

The NMFS will take several actions to decrease the contamination of harvested fish, including the following:

- Improve techniques to detect biotoxins, microbial, and chemical contaminants.
- Conduct research on the sources and distribution of contaminants, and their bioaccumulation in animal tissues.
- Estimate the amount and value of seafood that is lost through contamination, the cost of human illnesses associated with the consumption of contaminated seafood, and the shift in demand caused by perceptions related to contaminated seafood.

III.C. Marine Aquaculture

The importance of marine aquaculture, both in the U.S. and throughout the world, is widely recognized. The production limits of wild stock are being reached and most of the increased global production of fisheries products for the last decade have come from aquaculture. In many countries aquaculture is progressing more rapidly than in the U.S. In the U.S., aquaculture production has reached over 300,000 metric tons per year, with a value of \$800 million. Although aquaculture accounts for more than 22% of the value of our total landings, it makes up only 8% of the landed volume. World-wide, 20% of all fisheries products come from aquaculture, and 25% of all fish used for food.

There is significant potential to increase U.S. marine aquaculture or mariculture production, especially in closed systems on land, and in the EEZ. However, there are technical, environmental and socio-economic impediments that need to be addressed by basic and applied research and through an examination of policies. NMFS has scientific expertise that can be applied to all of these issues. NMFS has had a long history in aquaculture research and development, stretching back into the last century, and has made major contributions to the progress of aquaculture both domestically and internationally. Also, NMFS has environmental stewardship responsibilities and the expertise to assess the appropriate role of mariculture and its potential impacts on wildstocks and habitat quality. Finally, NMFS has certain responsibilities for permitting aquaculture projects, and it is important to use good science as a basis for establishing a clear policy for permitting decisions.

In addition to food production, aquaculture can also play a role in enhancing wildstock populations, assisting in recovery plans for protected species and can be used to produce non-food products such as ornamental fish, baitfish and drugs and pharmaceuticals. Expanded mariculture production in the U.S. has the potential to reduce the pressure on wildstock harvest and help in the rebuilding efforts for those stocks.

To ensure that mariculture progresses in an environmentally sound manner, NMFS will concentrate its mariculture research activities in the following broad areas:

- Develop aquaculture technology to improve production systems and safeguard the environment.
- Evaluate and develop commercially viable technology for new candidate species for aquaculture.
- Determine the requirements for the siting of aquaculture operations in the EEZ.
- Develop effective enhancement strategies for aquatic species to help recover wildstock fisheries and endangered species.
- Integrate aquaculture development with the management of wildstocks, threatened and endangered species and protect the environment to maximize the value of our aquatic resources for the benefit of the nation.
- Help develop world standards for environmentally sound and sustainable aquaculture.
- Conduct research on the effects of mariculture on habitat and develop environmentally safe alternatives.
- Evaluate the risk to wild stocks and their habitats from the introduction of cultured stocks.
- Develop the capability to distinguish cultured stocks from wild populations.
- Develop environmentally safe protocols for disease prevention.
- Assess the effectiveness of aquaculture as an alternative employment source for fishers in over-exploited fisheries.

IV. Information Management Research

Title IV (Fishery Monitoring and Research) Section 401 (Registration and Information Management) of the MSFCMA requires the Secretary of Commerce to deliver a proposal to Congress in January 1998, that recommends an implementation strategy for the development and integration of a standardized fishing vessel registration and fisheries information system (the “system”). The Sustainable Fisheries Act of 1996 (SFA) requires that the system include and integrate all fisheries information required under all applicable National Marine Fisheries Service (NMFS) statutory and regulatory requirements, including but not limited to MSFCMA, the Marine Mammal Protection Act, the Endangered Species Act, and the Atlantic Coastal Fisheries Cooperative Management Act. This section of SFA also states that the proposal will be developed in consultation with the Coast Guard, the states, the regional FMCs, the interstate Marine Fisheries Commissions, and any other key governmental, nongovernmental organizations, or interested stakeholders. The proposal for the system must be published in the Federal Register for public comment, in preparation for submission of the proposal to Congress in January 1998.

The proposal shall address NMFS statutory requirements for fisheries information, as well as incorporate mutual needs of states and tribes who wish to participate in the system. The fisheries information system will include information from both commercial and recreational fisheries, while the vessel registration system is to address commercial vessels only. The

need to register all recreational fishing vessels will be evaluated. The current development of the NMFS Core Statistics Program will be used to generate information required by NMFS, while existing State/Federal cooperative statistics planning programs (the Atlantic Coast Cooperative Statistics Program (ACCSP) and Pacific and Southwest Fisheries Information Networks (PacFIN, AKFIN), ComFin(Southeast), RecFIN(Pacific and Southeast) will be used to identify mutual information needs for states and the Federal government. In addition, gaps in information needs not yet identified by these programs will be identified through consultation with affected user groups. In addition to defining the requirements of the “system”, at least one prototype component of the “System” will be developed to demonstrate the benefits of integrated systems to internal and external stakeholders.

The proposal is expected to include the following:

- Recommendations for standardization of vessel registration and information collection systems required by SFA and other state and Federal enabling legislation.
 - Establishing standardized units of measurement, nomenclature, and formats for the collection, submission and management of data.
 - Establishing procedures for requiring commercial and recreational fishermen and ex vessel purchasers to participate in collection and reporting of fisheries information.
 - Inclusion of all species and all commercial fishing vessels (including charter fishing vessels) within the geographic areas of authority of the FMCs.
 - Assessing the desirability or necessity of creation of a vessel registration system for recreational fishing vessels (not including charter fishing vessels).
- Recommendations for integrating information collection programs under existing FMPs and integrating other state, tribal, and Federal fishery information systems to reduce avoid duplication and minimize paperwork and other burdens on affected parties.
- Recommendations on mechanisms and vehicles through which stakeholders and industry participants can effectively implement new, integrated systems.
- Estimates of costs and possible funding mechanisms and schedules associated with implementing the recommendations for the system.
- Recommendations for modification of statutory impediments to implementation of the system or modifications of statutes to enable implementation of the system.

Major Fishery Research Goals and Objectives

All Federal agencies operate in an environment of limited resources, budgetary constraints, and increasing demands. It is very clear that in order to succeed in accomplishing our ambitious set of fishery research goals and objectives, NMFS needs to increase its partnering activities with other Federal agencies as well as with other NOAA line offices and their programs (such as Sea Grant, the National Undersea Research Program, and the Coastal Ocean Program), state and local authorities, universities, Native American tribes, Pacific Islanders, the commercial and recreational fishing industries, environmental groups, and

international organizations. NMFS is committed to strengthening existing relationships and building new ones.

The major fishery research goals and objectives can be found under the goals and objectives in the *NOAA Fisheries Strategic Plan* (FSP), published in May 1997. To facilitate cross reference, the corresponding FSP strategy or foundation number follows each fishery research objective found below.

GOAL 1: Provide scientifically sound information and data to support fishery conservation and management. (Ongoing)

Objective 1.1: Periodically assess stocks to ascertain whether changes in their status due to natural or human-related causes have occurred. These stock assessments require adequate fishery monitoring and resource surveys. (FSP Strategy 1.1.1)

Objective 1.2: Use stock assessments to predict future trends in stock status. Forecasts will take into account projected biological productivity, as well as economic market, and social forces that will affect levels of fishing effort. (FSP Strategy 1.1.2)

Objective 1.3: Determine and reduce the level of uncertainty associated with stock assessments through improved data collection and advanced analytical techniques. (FSP Strategy 1.2.1)

Objective 1.4: Use stock assessment workshops and other fora to ensure that our information and advice are developed through an open and collaborative process. (FSP Strategy 1.2.2)

Objective 1.5: Communicate our scientific information and advice, along with the associated uncertainties, to the Councils and other management authorities, and to other interested parties. (FSP Strategy 1.1.3)

Objective 1.6: Collaborate with the Councils and other management authorities to develop fishery management regimes that will effectively control exploitation. (FSP Strategy 1.1.4)

Objective 1.7: Provide guidelines to assist the Councils in assessing and specifying maximum sustainable yield for managed fisheries. (FSP Strategy 1.1.5)

Objective 1.8: Work with the Councils to develop objective and measurable criteria for each managed stock to determine if the stock is overfished or approaching an overfished condition. (FSP Strategy 2.1.1)

Objective 1.9: For each stock which is overfished or approaching an overfished condition, we will develop, in collaboration with the Councils, measures to eliminate or prevent the overfishing. (FSP Strategy 2.1.2)

Objective 1.10: Establish guidelines to assist the Councils in the description and identification of EFH, as defined and mandated by the SFA. (FSP Strategy 2.3.1)

Objective 1.11: Establish an inventory of living marine resource habitats (tied to *Our Living Oceans*) and implement measures to monitor the trends in habitat availability. (FSP Strategy 7.3.3)

Objective 1.12: Establish criteria to define and delineate marine, estuarine, and riverine ecosystems for management purposes, and identify indicators for assessing the status and detecting changes in the health of such ecosystems. (FSP Strategy 7.3.2)

Objective 1.13: Define the key aspects of vital habitat functions and increase our understanding of how they affect marine and anadromous species and how they are affected by human activities. This will involve the development of new methods of evaluating the quality and productivity of restored habitats, as well as improved restoration and creation technologies, including contaminant remediation, to ensure that created habitats are effective. (FSP Strategy 7.3.1)

GOAL 2: Through conservation engineering research contribute to efforts to reduce bycatch and adverse effects on EFH, promote efficient harvest of target species, and to improve the data from fishery surveys. (Ongoing)

Objective 2.1: Identify and assess the magnitude of incidental takes of protected marine species. (FSP Strategy 6.1.1)

Objective 2.2: Establish sustainable levels of takes for all protected marine species and continue to improve the estimates of these levels through ecologically sound research. (FSP Strategy 6.1.2)

Objective 2.3: Work through domestic and international cooperative relationships with industry and environmental groups, including take reduction teams, special task forces, and other needed scientific collaborations. (FSP Strategy 6.1.3)

Objective 2.4: Explore, develop, and implement new technologies and practices for reducing detrimental interactions. When such technologies could reduce detrimental effects both to and from protected species in other nations these technologies will be made available to those nations. (FSP Strategy 6.1.5)

Objective 2.5: Establish a standardized reporting methodology to assess the amount and type of bycatch occurring in each fishery covered by an FMP. (FSP Strategy 3.4.1)

Objective 2.6: Work in cooperation with the fishing industry and gear manufacturers to improving gear selectivity, design and field test new gear designs and modifications, and evaluate gear regulations. (FSP Strategy 3.4.2)

GOAL 3: Through ecological research on marine communities and ecosystems, and fishery research provide scientific information and data to increase long-term economic and social benefits to the Nation from living marine resources. (FY 2003)

Objective 3.1: Develop social and economic models and collect the data needed to measure net economic and social benefits to the Nation from living marine resources. (FSP Strategy 3.1.1)

Objective 3.2: Assist the Councils in reviewing optimum yield levels for consistency with the revised definition in the Sustainable Fisheries Act. (FSP Strategy 3.2.1)

Objective 3.4: Work with the National Academy of Sciences to develop a comprehensive report on individual fishing quota programs, including recommendations to implement a national policy with respect to such programs. (FSP Strategy 3.3.3)

Objective 3.5: Study new candidate species for culture through their complete life cycle to determine which are economically and biologically suitable for commercial culture or wild stock enhancement. (FSP Strategy 4.1.1)

Objective 3.6: Determine requirements for the siting of aquaculture operations in the Exclusive Economic Zone (EEZ). (FSP Strategy 4.4.1)

Objective 3.7: Work with the aquaculture industry to develop, identify, evaluate, and transfer technologies that are appropriate to both efficient aquaculture production and environmental protection. (FSP Strategy 4.5.1)

GOAL 4: Improve the fishery information management system. (FY 2003)

Objective 4.1: Develop recommendations for implementation of a standardized fishing vessel registration and information management system which will include all commercial and charter fishing vessels within the geographic authority of the Councils, and make recommendations regarding the inclusion or exclusion of recreational fishing vessels. (FSP Strategy 3.3.2)

Objective 4.2: Provide the NMFS Core Statistic Program. (FSP Foundation F1.10)

Goal 5: Improve the effectiveness of external partnerships with fishers, managers, scientists, conservationists, and other interested groups to build a balanced approach to addressing fisheries research. NMFS and its partners must develop ways to strengthen and expand cooperative relationships to meet common fisheries research goals. (Ongoing)

Objective 5.1: Promote a cooperative network of partners in the coordination of fisheries research.

Objective 5.2: Develop infrastructure for long-term, continuous working relationships with partners to address fisheries research issues.

Objective 5.3: Sponsor symposia and conferences for partners to exchange information and identify major fisheries research initiatives.

Objective 5.4: Solicit partners' views on fisheries research needs.

APPENDIX A: NMFS SCIENTIFIC ENTERPRISE

The National Marine Fisheries Service is the NOAA line office responsible for the stewardship of the Nation's living marine resources. It has five (5) Regional Offices which are responsible for ensuring that these resources are managed conservatively to benefit the nation without jeopardizing options for the future. NMFS also has five (5) Regional Science Centers, composed of about 30 laboratory facilities nationwide and over 1500 scientific and support personnel, which conduct a comprehensive, interdisciplinary science program. The scope of their work is broad in time, space, and discipline. Research at NMFS laboratories provides resource managers in NOAA, Fishery Management Councils, and other agencies with the scientific basis for informed marine resource management decisions for sustainable fisheries, protected resources, endangered species, and habitat.

Because fisheries are managed on a regional basis, the focus of NMFS research programs varies among the regional Science Centers. It is the responsibility of each Science Center Director and his/her Division Chiefs to develop annual research priorities, based upon regional and national needs, through dialogue with his/her Regional Administrator, with the Program Offices in NMFS headquarters, and with user groups and other interested parties. Within each Science Center, teams of researchers work together with their group leader to develop a research plan for the group.

NMFS' longer-term integrated research program is coordinated with the headquarters' Office of Science and Technology. The Science Board, composed of the five (5) Science Center Directors and the Director of the Office of Science and Technology, is responsible for ensuring the integrity and quality of scientific research. The NMFS Science Board addresses national science issues and programs and develops national science policy for the agency. All components of the science enterprise function to provide the agency with information that is comprehensive, objective, credible, and effectively communicated.

The NMFS science program has extensive collaborations with academia, many through cooperative agreements and grants. These partnerships are important because they enhance and extend NMFS' research capability. Many NMFS scientists serve as adjunct professors at nearby universities. This relationship offers intellectual stimulation and challenges for agency scientists to remain on the cutting edge, while expanding the teaching capability of the university and bringing NMFS expertise into the academic community. Academic scientists also play an important role in the periodic review and evaluation of the quality and relevance of NMFS research programs. The Science Centers work in cooperation with other Federal and state agencies, international entities, nongovernmental organizations, and the private sector, including the fishing industry.

Some major research initiatives focus on the needs of the fisheries industry and are performed in cooperation with industry. For instance, joint studies of harvesting methods and development of more effective fishing gear are reducing wasteful bycatch. Seafood science research is aimed at proper handling of seafood to prevent crises in microbial or chemical seafood contamination and at developing technology for full utilization of harvested fish. Other research initiatives focus on needs of the FMCs and NMFS Habitat Conservation field offices to meet their scientific and management mandates under the EFH provisions of the MSFCMA.

GOALS OF THE SCIENTIFIC ENTERPRISE

The mission of NMFS scientific enterprise is to ensure that the scientific information disseminated by the National Marine Fisheries Service is of the highest quality. During the next five years NMFS will accomplish this by meeting the following goals and objectives:

Improve Scientific Capability

- Develop new science-based resource assessment and management techniques, including multi-species, habitat-linked and limited access approaches to living marine resource conservation and management. (Ongoing)
- Increase our ability to incorporate economic and social factors into our decision-making. This includes expanding the publication *Our Living Oceans* to include economic and sociocultural assessments of the Nation's fisheries. (FY 1997)
- Increase our ability to predict natural living marine resource variation through improved data collection and coordinated bio-socio-economic modeling, which will result in more accurate assessments and estimations of the uncertainty associated with them. (Ongoing)
- Increase our ability to identify, protect, and restore those habitats essential to managed fishery resources and to estimate the impact of pollution, wetland and estuarine degradation, and fishing gear on the abundance and availability of fish. (Ongoing)

Increase Science Quality Assurance

- Implement policies to ensure that our science programs, analyses, and products are sound, credible, and provide an objective basis for management. (Ongoing)

- Improve our professional standards for research and scientific advice by establishing national guidelines for technical program and staff performance evaluations, performance award programs, and professional career development opportunities. (FY 1998)
- Expand and improve our system for peer review of scientific advice by establishing panels of knowledgeable scientists from both within and outside government. (FY 1998)
- Solicit input from external scientists in topical areas when identifying research initiatives for the various NMFS grant programs. (FY 1998)

Improve Fishery Research Capability

- Implement our vessel replacement plan that integrates government, university, and industry vessel capabilities to provide the state-of-the-art facilities necessary for the advancement of our varied at-sea research programs. (FY 1998-2005)

Improve Data Collection

- Improve our data collection and analysis techniques and systems. (Ongoing)
- Improve our fishery management data systems. (Ongoing)
- Provide a core fishery statistics program based on our strategic and operational needs. (FY 1998)

Increase Outreach/Information Dissemination

- Involve constituents in research programs. To the extent practicable, NMFS will charter fishing vessels to participate in research projects, invite constituents to participate aboard NOAA research vessels during resource surveys, encourage frequent contact and cooperation between scientists and constituents, and develop methods to incorporate scientifically valid observations by fishers and others into fish stock assessments and other analyses related to living marine resources and their habitat. (Ongoing)
- Provide a forum for educating user groups and answering questions concerning how NMFS research is conducted and how stock assessments are performed. (FY 1997)
- Develop a new series of reports and presentations to communicate scientific results in simplified language that is easier to understand than traditional scientific publications. (FY 1997-2000)

Support International Fishery Science

- Participate in international scientific initiatives, such as the UN Intergovernmental Panel on Climate Change (IPCC), Program for the Conservation of Arctic Flora and Fauna (CAFF), Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Food and Agriculture Organization of the UN (FAO), Global Oceans Observing Program (GOOS), North Pacific Marine Science Organization (PICES), International Council for the Exploration of the Seas (ICES) and Global Ecosystems Dynamics (GLOBEC). (Ongoing)
- Participate in bilateral scientific initiatives with neighboring countries, Canada and Mexico, and in scientific exchange programs with foreign countries which are developing their fishery resources. (Ongoing)

NMFS FISHERIES SCIENCE CENTERS

The National Marine Fisheries Service is a world leader in fisheries research. Each year the agency uses harvest and survey data to assess the status and trends of more than 231 commercially valuable fish and shellfish stocks. The NMFS Science Centers provide the stock assessment information and management advice to support the NOAA stewardship mission for the living marine resources in their regions. These cross-disciplinary efforts are being undertaken in cooperation with other Federal and state agencies, international organizations, the fishing industry, and academia, and are based on long-standing cooperative research. In addition to these basic responsibilities, each regional Science Center has unique research capabilities.

ALASKA FISHERIES SCIENCE CENTER (AFSC)

The Alaska Fisheries Science Center (AFSC) has facilities in Seattle, Washington; Newport, Oregon; Auke Bay, Alaska; and in Kodiak, Alaska. The Center has an annual budget of approximately \$30 M and a staff of 310 employees. The NOAA ships *Miller Freeman* and *John N. Cobb*, supplemented by private charter vessels and foreign research vessels, are used to support research activities. The majority of the budget and duties of employees (roughly 80% of both) are focused on research which directly supports the Magnuson-Stevens Fishery Conservation and Management Act and its mandates.

The AFSC conducts fisheries research in the coastal waters off Alaska and the U.S. West Coast. This region of nearly 3 million square miles includes over 50% of the U.S. coastline and over 70% of the U.S. continental shelf. These waters, including the eastern North Pacific

Ocean, Gulf of Alaska, and eastern Bering Sea, support some of the most important commercial fisheries in the world including groundfish and Pacific salmon. These waters are also home to some of the world's largest populations of marine mammals and seabirds.

Scientists from the AFSC conduct field and laboratory research to help conserve and manage the region's living marine resources as mandated by the MSFCMA, Marine Mammal Protection Act, and Endangered Species Act. Center scientists study the life histories and ecology of the region's living marine resources. They also estimate the size and value of commercial fishery resources, monitor fishing operations, provide information on protected species such as marine mammals, study the physical and biological properties of freshwater, estuarine, and marine environments, and provide economic analyses of existing and proposed conservation and management measures. Center scientists interact with their counterparts in Canada, Japan, Russia, Republic of Korea, Taiwan, China, and other nations.

The AFSC has a history of habitat/fisheries research, including the impacts of oil pollution and logging on habitat. Some of these studies have resulted in the passage of new laws, settlement of allocation disputes, and restoration activities. Much of this work has been soft-funded by other agencies, including ongoing restoration work that is funded by the Exxon Valdez Trustee Council. In recent years, the Center's habitat research has expanded to assess environmental impacts from trawling and other issues related to EFH. AFSC scientists use expertise in stock identification, tagging, use of parasite markers, and genetic technologies to study carrying capacity and habitat utilization by living marine resources.

The Center also provides scientific data and technical advice to the Pacific and North Pacific Fishery Management Councils, to U.S. representatives participating in international fishery negotiations, and to the fishing industry and its constituents.

The AFSC consists of the Auke Bay Laboratory (ABL), the National Marine Mammal Laboratory (NMML), the Resource Assessment and Conservation Engineering Division (RACE), the Resource Ecology and Fisheries Management Division (REFM), and support and administrative services.

The AFSC's role as a provider of scientific information on which to base decisions for the conservation of the region's living marine resources is a virtual partnership involving many organizations, both private and public, working together to accomplish the research and conservation goals of the Center's research programs. Cooperators include other organizations within NOAA, other Federal and state agencies, academic institutions, foreign nations, and the fishing industry. In particular, the fishing industry is involved with the Center's research program through participation in resource surveys that use chartered vessels, service as members of an advisory committee to the fisheries observer program and

working cooperatively with the scientists in the Conservation Engineering Program and the Economics Program.

The Center provides the scientific information necessary to manage the following fisheries under Federal management:

Groundfish Fishery - Bering Sea-Aleutian Islands
 (Major Species 14)
 (Minor Species 20)
Groundfish Fishery - Gulf of Alaska
 (Major Species 14)
 (Minor Species 37)
King and Tanner Crab Fisheries - Bering Sea-Aleutian Islands
High Seas Salmon Fishery
Pacific Halibut Fishery
Scallop Fishery
West Coast Fishery

Major scientific programs include:

- Acoustic, trawl and longline surveys to assess the status, distribution, and abundance of groundfish and shellfish stocks;
- Fishing gear performance and fish behavioral studies to reduce bycatch and bycatch mortality of prohibited, undersized, or unmarketable species, and understand performance of survey gear.
- Investigation of mortality and pathogens of shellfish and groundfish;
- Fisheries Oceanography Coordinated Investigations (FOCI): Cooperative research with the Pacific Marine Environmental Laboratory of NOAA's Oceanic and Atmospheric Research Office to investigate the causes of variation in annual recruitment in fish stocks;
- A fishery observer program for domestic vessels and shore-side processing plants;
- Development of age and growth information used in stock assessments;
- Stock assessments on groundfish and shellfish and research to improve these assessments and their ecological scope;

- Collection and analysis of information on trophic interactions;
- Analyses of conservation and management measures and research to improve them;
- Assessments of the economic performance of the Alaska groundfish and halibut fisheries and research to improve these assessments;
- Identification of essential fish habitat.
- Analyses on the interactions of marine mammals with fisheries including research on impacts of pinniped predation on ESA-listed salmon;
- Studies on the growth, distribution, behavior, and early marine survival of salmon;
- Research on chinook salmon enhancement technology;
- Studies on determination of effects of oil on the biology, homing, and survival of pink salmon;
- Development of genetic baseline information on salmonids and groundfish to identify stocks or country of origin;
- Studies on impacts of logging, urbanization, mining, and fishing gear;
- Damage assessment and restoration studies related to the *Exxon Valdez* oil spill.

NORTHWEST FISHERIES SCIENCE CENTER (NWFSC)

The Northwest Fisheries Science Center (NWFSC) is located in Seattle, WA. There are five field stations: Manchester, Mukilteo and Pasco, Washington; and Newport and Pt. Hammond, Oregon. The Center employs about 220 scientists and support staff, of which 140 are involved with MSFCMA-related research. The annual research budget for MSFCMA-related research at the Center is \$16.7 M, including reimbursable funding from Federal co-managers for critical work on endangered and depleted salmon populations and habitat restoration efforts. In FY 1996, approximately \$1.5 M was awarded in contracts and grants to universities, state agencies, and the private sector for support of MSFCMA research. Several small vessels are owned by the Center for

conducting field studies in Puget Sound, WA (RV *Harold Streeter*) and the Columbia River area (RV *Sea Otter*, RV *Nerka*, RV *Columbia*).

The Northwest Fisheries Science Center provides the scientific base for sustainable fisheries research in the Pacific Northwest, focusing primarily on Pacific salmon and the west coast groundfish fishery. Center scientists have pioneered new methodologies for monitoring and survival estimation of juvenile and adult salmon, particularly in the Snake and Columbia Rivers; have developed enhancement strategies to sustain growth of depressed salmonid populations; and are investigating the factors limiting Pacific salmon populations in estuarine, coastal, and ocean environments. Center staff are leading experts in developing and implementing genetic tools for identifying salmonid and other populations, determining mixed-stock components of terminal and high-seas fisheries, and evaluating the effects of artificial propagation on natural populations and its efficacy in restoring endangered salmonid and other populations. The Center has undertaken a broad and unique research program directed toward enhanced production of marine finfish species to help rebuild depleted stocks. This includes developing state-of-the-art technologies for production of juveniles, including captive broodstocks, and determining optimal rearing, acclimation, disease control and prevention, and release strategies to assure the success of localized enhancement efforts. Salmon fishery models are being developed to provide the basis for more selective harvest in multispecies salmon fisheries. The NWFSC also has front-line responsibility for conducting multispecies population assessments of west coast groundfish stocks, improving the breadth and precision of those assessments, and studying the impacts of bycatch in groundfish fisheries through collaborative projects with universities and industry. The Center has demonstrated its unique capabilities in developing new seafood processing methods which eliminate huge amounts of waste by more fully utilizing harvested fish and underutilized fish species, and in transferring these technologies to the seafood industry. The Center is known worldwide for its ability to assess threats to habitat quality (e.g., from chemical contaminants, toxic phytoplankton, and toxic spills) and to the productivity and quality of fishery resources. The NWFSC is also pursuing development of quantitative indicators of the integrity and health of coastal and estuarine ecosystems which can be applied worldwide, and is providing rapid response to environmental emergencies on both the west and east coasts (e.g., *Exxon Valdez* and *North Cape* oil spills, and harmful algal blooms) and critical scientific information to mitigate the biological and economic impacts from harvest closures on fishery-dependent communities. The Center provides scientific information for two FMP's:

- Groundfish Fishery of the West Coast
 - Includes 83 species with varying degrees of over-/under-exploitation and a wide range of knowledge regarding stock status.
- Salmon of the West Coast

The Northwest Fisheries Science Center provides scientific and technical support to NMFS for management and conservation of the Northwest region's marine and anadromous resources and their habitats. The NWFSC's four divisions conduct applied research to resolve problems that threaten these resources or that impede their use. NWFSC staff develop the scientific base required for reports on status of stocks and of fisheries, environmental assessment and environmental impact statements for management plans and international negotiations; and pursues research to answer specific management needs in habitat conservation, endangered and protected species, aquaculture, and full utilization of harvested fish.

The NWFSC has an open and active dialogue with fishermen and other constituents. Through this dialogue, several areas of cooperative work are being developed. Constituents also provide input to research planning through comments on the "Research and Data Needs" of the Pacific Fishery Management Council.

SOUTHWEST FISHERIES SCIENCE CENTER (SWFSC)

The Southwest Fisheries Science Center (SWFSC) headquarters is located in La Jolla, California and research is conducted at laboratories located in La Jolla, Tiburon, and Pacific Grove, California; and Honolulu, Hawaii. The current staffing level involved in MSFCMA-related activities is at about 156 full-time equivalents (FTEs). An estimated 65% of total SWFSC resources are assigned to direct MSFCMA activities. NOAA research vessels assigned to fisheries research in the SWFSC are: the *Townsend Cromwell* assigned to the Honolulu Laboratory, and the *David Starr Jordan*, which has San Diego, California, as its homeport.

The SWFSC conducts integrated, multidisciplinary, research programs in biology, mathematics, oceanography, and economics for the purpose of developing scientific information to support the management and allocation of Pacific coastal, insular, and high-seas fishery resources. These activities are designed to support the scientific, statistical and economic needs of both the Western Pacific and the Pacific Fishery Management Councils and international commissions for large pelagic fishes and Antarctic resources as well as efforts directed toward the reduction of fishery-related porpoise mortality and a better understanding of the biological and environmental factors affecting the marine resources exploited by U.S. commercial and recreational fisheries. The Center provides the scientific information necessary to conserve and manage the following important fisheries in the Pacific region:

- Large pelagic fishes of the eastern, central and western Pacific (tuna, billfish, shark, swordfish)

- Crustaceans of the central Pacific (lobster)
- Precious corals of the central Pacific
- Bottomfish and seamount species of the western Pacific
- Groundfishes of the West Coast (Pacific hake, rockfishes, lingcod)
- Small coastal pelagic species of the West Coast (Northern anchovy, sardine, mackerel, squid)
- Salmon of the West Coast
- Antarctic krill

The Southwest Fisheries Science Center specializes in fisheries of the California Current, Pacific oceanic, and Antarctic regions. In the California Current, research is carried out on the ecology, population dynamics, fisheries and stock assessment of small coastal pelagic species, west coast groundfishes, billfish and tunas, and California salmon. The Center maintains and utilizes the largest database on tuna and tuna-related fisheries in the world. It is also considered a leader in fish survey design, conducting surveys to monitor early recruitment success of economically important fish stocks along the U.S. West Coast, using state-of-the-art survey methods developed at the Center. It is a co-participant in the State-Federal California Cooperative Fisheries Investigations, a comprehensive long-term study of the biology and oceanography of the California Current. The Center has unique expertise in ocean climatology and access to ocean time series data bases and ocean index products which it distributes to scientists around the world for fisheries research applications. In the oceanic Pacific, the Center is the leading source of stock assessment expertise on tropical island and oceanic resources, especially bottomfishes, lobster, tunas and billfishes. In the Antarctic, the SWFSC leads U.S. research directed at gathering ecological information to prevent overexploitation of fish and krill and to protect Antarctic living marine resources.

SWFSC scientists have taken the lead in characterization of large- and small-scale habitats that support groundfish populations in deep water. This work requires an interdisciplinary approach from fishery biologists, geologists, and ecologists and couples the use of geographic information systems (GIS) with remote-sensing acoustic tools, *in situ* survey techniques using submersibles, and spatial analyses. This approach is being applied to the identification of EFH, the improvement of stock assessment surveys, and the evaluation of harvest refugia as an effective supplement to traditional fishery management.

The SWFSC maintains an active communications network with constituents, colleagues in the scientific professions, and the public to receive input for research planning, execution and results. The network includes frequent dialogue with commercial and recreational fishers, leaders of environmental groups, participants of FMCs, state and Federal research agency staff, and outside scientists in the United States and foreign

countries. Supporting this network is an infrastructure that includes cooperative agreements to support collaborative work with researchers in state agencies, universities, and foreign government agencies for collecting logbook and other types of fisheries data and for shared research projects; arrangements for data exchange; and contracts for charters of research vessels and specialty expertise.

The Southwest Fisheries Science Center maintains a world-class fisheries economic research capability, which is often supplemented with funding from the FMCs. Special studies are undertaken to help explain and evaluate the potential impacts of various management options on components of the fishery or the public. In addition, economic data collection and analyses are carried out to evaluate the economic health of fisheries or components of the fisheries. The SWFSC economists have always had a strong leadership role in the development and maintenance of economic databases within the Pacific Fisheries Information Network (PacFIN).

SOUTHEAST FISHERIES SCIENCE CENTER (SEFSC)

The Southeast Fisheries Science Center (SEFSC) headquarters is located in Miami, Florida and research is conducted at laboratories located in Beaufort, North Carolina (with field station at Oxford, Maryland); Charleston, South Carolina; Miami, Florida; Panama City, Florida; Pascagoula, Mississippi (with field station at Stennis Space Center); and Galveston, Texas (with field station at Lafayette, Louisiana). Each laboratory is responsible for conducting research in specific subject areas and for providing services to facilitate the work of the Center units. The current staffing level of the SEFSC is 341 FTEs. All positions are involved to some extent in MSFCMA-related activities. About 80% of total SEFSC resources (\$24 M base funds) are assigned to direct MSFCMA activities. Three NOAA vessels assigned to fisheries research are homeported in Pascagoula, MS: *MV/Oregon II*, *MV/Chapman*, and *MV/Relentless*.

The Southeast Fisheries Science Center provides the science base for U.S. sustainable fisheries on Atlantic south temperate, subtropical and oceanic fishery resources. Center scientists support the fishery management activities of NMFS and three fishery management councils (South Atlantic, Gulf of Mexico, Caribbean) that involve 17 fishery management plans, including the following major fisheries:

- Spiny Lobster
- Snapper-Grouper
- Reef Fish
- Red Drum
- Coastal Migratory Pelagic Species

- Coral
- Shrimp
- Stone Crab
- Queen Conch

The Center also provides scientific support for U.S. participation in the International Commission for the Conservation of Atlantic Tunas (ICCAT), which manages Atlantic Ocean-wide fisheries for tunas and billfishes, and in the International Oceanographic Commission for the Caribbean (IOCARIBE), which coordinates fishery oceanography studies among the 30-some island and continental countries in the region. The interactions of protected species (e.g., sea turtles, bottlenose dolphin and anadromous sturgeon) with ongoing fisheries in the Southeast Region is of particular concern. The Center has international recognition for fishing gear engineering, particularly in the development of bycatch reduction technology for both fish and sea turtles. The Center is also recognized for its expertise in the fields of habitat research, biotechnology and ecotoxicology. Current and envisioned research that addresses MSFCMA and EFH fall into four areas: identification, restoration, and mapping of EFH, and identification of threats to both EFH and fishery resources. Researchers at the SEFSC are working with other state and Federal agencies and academia on research plans to restore ecological integrity and water quality in Florida Bay, Chesapeake Bay, and other estuaries on which fish depend. The Center is conducting research to restore and enhance coastal habitats from Narragansett Bay to Florida Bay on the Atlantic coast, Tampa Bay to Laguna Madre on the Gulf of Mexico coast, and in San Francisco and San Diego Bays on the Pacific coast. Researchers work closely with the NOAA Damage Assessment and Restoration Program on Superfund and oil spill sites and in conjunction with Coastal Wetland Planning, Protection, and Restoration Act activities in Louisiana. SEFSC researchers conduct research on the impact of contaminants on fishery resources, food web production, and habitat. The NMFS Southeast Regional Office and SEFSC habitat research staff have met on a 3-5 year basis since the 1970s to coordinate habitat-related research and effectively address the information needs of habitat managers and Fishery Management Councils.

Habitat-related research in support of the MSFCMA by SEFSC scientists will primarily address four major areas: (1) description of EFH; (2) identification of EFH; (3) restoration of EFH; and (4) threats to fishery species and EFH. Research to describe EFH will employ increased use of remote-sensing platforms along with ground-truthing and remotely-operated video to assess habitat type and quality and environmental parameters such as salinity, water temperature and clarity. Identification of EFH research will be designed to identify primary cues (e.g., temperature, salinity, current) used by pre-adults of commercially and recreationally important fishery species for recruitment from ocean spawning areas to coastal and estuarine habitats using remote sensing, algorithm

development and field surveys. Restoration of EFH research will emphasize innovative techniques to determine the functional value of natural habitats and evaluation of restoration success relative to the fish community rather than solely of the plant community. Finally, research on threats to fishery species and EFH will continue to emphasize the effects of metals and organic contaminants on different life history stages of fishery organisms.

The SEFSC is responsible for scientific research on the living marine resources which occupy marine and estuarine habitats of the continental southeastern United States, as well as Puerto Rico and the U.S. Virgin Islands. The Center supports large marine ecosystem programs performing fishery research. Scientists conduct resource surveys and collect and report fisheries statistical data. SEFSC staff develop the scientific information base required for fishery resource conservation, fishery development and utilization, habitat conservation, and protection of marine mammals and endangered species. They also prepare impact analyses and environmental assessments for management plans and international negotiations; and pursue research to answer specific needs in population dynamics, fishery biology, fishery economics, engineering, and food science. SEFSC scientists regularly assess the status of managed fishery stocks, determine overfishing conditions, and provide scientific input to developing and monitoring recovery plans, using state-of-the-art production, catch-at-age, and stock-recruitment models.

The fishing industry in the Southeast Region has been and continues to be especially active in developing trawl fishing gear that excludes sea turtles and reduces fish bycatch. The SEFSC Conservation Engineering Team has worked closely with representatives of the southeastern fishing industry in developing, testing, and modifying turtle excluder devices (TEDs) and bycatch reduction devices (BRDs). Several designs have been suggested by industry and prototypes have been developed and tested with industry cooperation.

Special studies in the southeast Region are carried out with industry cooperation. Currently a commercial fishing vessel is chartered to conduct a tagging study on red drum to estimate population size and age composition of this species in the Gulf of Mexico. Industry participates in scientific data collection through the submission of fisherman and dealer logbooks and reports, under both voluntary and mandatory programs.

The NMFS Southeast Region held meetings with “stakeholders” in the fall of 1996 to gather input from its constituency. A meeting was held in each of three regions (southern Atlantic Coast-Charleston, Gulf of Mexico-New Orleans, and Caribbean-Ponce, Puerto Rico). Representatives of fishing organizations, environmental organizations, and state and other Federal agencies were invited and participated in setting goals for the NMFS

long-range Strategic Plan. Constituents also have opportunity to participate in the fishery management process through representation on FMCs, participation in Council public hearings, and service on Council advisory committees. Input to the SEFSC research program is also received through participation in the activities of interstate fishery commissions (Atlantic and Gulf States Marine Fisheries Commissions), joint agency planning groups, and cooperative programs with state fishery agencies (ComFIN and RecFIN). 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 information requirements.

Scientific program reviews are held periodically and program review teams include officials from industry, Councils, state agencies, and universities to ensure a broad representation of views. The Southeast Region, works diligently to be responsive to living marine resource/fishery conservation and management information needs, as expressed through these program reviews.

NORTHEAST FISHERIES SCIENCE CENTER (NEFSC)

The Northeast Fisheries Science Center (NEFSC) has facilities in Woods Hole, Massachusetts; Narragansett, Rhode Island; Milford, Connecticut; Sandy Hook, New Jersey (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, D.C.). Two NOAA research vessels (*Albatross IV* and *Delaware II*) are berthed in Woods Hole, MA and support the majority of the Center's fisheries survey and research cruises. Periodically the NOAA ships *Chapman* and *Oregon II* (berthed in Pascagoula, Mississippi) 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. In FY1996 the NEFSC obtained roughly \$4.7 M in extramural grants and contracts support which was used to supplement its base budgetary allocation (\$26.8 M and 270 FTEs in FY1996). Most of this extramural funding came from either NMFS Headquarters or other line offices within NOAA. The Northeast Regional Office (NERO) State and Federal Division expended roughly \$30 M in FY1996 for research grants supporting the fishing industry (through the Saltonstall-Kennedy Program and Fishing Industry Grants).

In the Northeast, peer review of stock assessments is conducted twice per year within the Northeast Regional Stock Assessment Workshop (SAW) process. The SAW process is guided by the SAW Steering Committee (directors of NEFSC and NERO, Mid-Atlantic

Fishery Management Council [MAFMC], New England Fishery Management Council [NEFMC], and Atlantic States Marine Fisheries Commission [ASMFC]) which determines which species to assess during a particular SAW cycle and establish 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-session Public Review Workshop held during planned meetings of the MAFMC and NEFMC. 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; and industry members. 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. In FY1997 the National Research Council (NRC) will review the Northeast groundfish assessment for five stocks (Gulf of Maine cod, Georges Bank cod, haddock and yellowtail flounder, and Southern New England yellowtail flounder) under a Congressional mandate contained in the Sustainable Fisheries Act (SFA).

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 on 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 and surf clams, sea scallops, and grant funds are provided to support surveys of Gulf of Maine Northern shrimp and finfish surveys in state waters. The survey data is employed in Stock Assessment Workshops that include participation by state, academic and non-government organizations (NGOs) fisheries experts in developing consensus estimates of stock size for managed species of finfish and shellfish. This advice is utilized by the MAFMC and NEFMC. 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 and juvenile cod and haddock; biological characteristics of selected shark species in the Northeast; roles of sand lance and herring as food for Humpback whales; and descriptions of an EFH for most coastal finfish species. The Center also conducts social and economic research in support of the fishery management process.

Much of the recent gear research in the Northeast has been accomplished through grants, with Regional Office 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). A resolution to this problem will allow fishing to continue. The fishing industry aided this effort through its participation in the Gear Advisory Group meeting to devise solutions and by volunteering vessels and time for observations and testing. Also, several of the Regional Office Divisions and the Center are collaborating on experiments using pingers as deterrents to marine mammal entrapment in gillnets.

NEFSC Research Priorities:

I. Research to Support Fishery Conservation and Management

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

- Maintain/improve fishery independent data collection systems (sampling design, intensity, and improved data collection and archiving).
- Enhance sea sampling programs (sampling design, intensity, and database management).
- Develop improved biological parameter estimates.
- Develop multispecies models for the Georges Bank Ecosystem.
- Develop improved assessment methods.
- Revision of the 1953 classic “Fishes of the Gulf of Maine” by Bigelow and Schroeder covering identification, distribution and biology of the 260 species recorded from the Gulf. (Sections are being used for identifying and describing critical habitat for 14 species for the NEFMC Multispecies FMP and six species for the MAFMC, the Bluefish FMP, the Squid, Mackerel, and Butterfish FMP, and the Summer Flounder, Scup, and Black Sea Bass FMP)

- A top-down review of cephalopod systematics using modern cladistic methods based on both morphology and DNA sequence analysis. (In cooperation with scientists at the University of Hawaii and the College of William and Mary)
- Systematics, evolution and biogeography of the genus *Callinectes* for a multi authored book on the blue crab, *Callinectes sapidus*.
- Catalogue of the approximately 150 species of tongue soles in the family Cynoglossidae for an FAO Species Catalogue.
- Catalogue of the approximately 220 species of beloniform fishes (flyingfishes, sauries, halfbeaks, and needlefishes) of the world in cooperation with N.V. Parin of the Russian Academy of Sciences for an FAO Species Catalogue.
- Differences between genera and selected species of spiny lobsters (Palinuridae) based on structure of their large antennae.
- Determine biological, environmental and habitat processes controlling the reproductive success of important fishery resource species.
- Develop micro constituent chemical analysis techniques for stock identification of bluefin tuna and other species.
- Monitor oceanographic and biological conditions on the northeast shelf to document ecosystem variability and determine its role in the recovery and sustainability of depressed fish stocks.
- Improve, with cooperations of states, the collection of biological samples characterizing age structure of stocks.

B. Interdependence of fisheries or stocks of fish -Investigate the importance of trophic interactions between the populations of bluefish and striped bass.

C. Identification of essential fish habitat

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

D. Impact of environmental changes on fish populations

- 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

- Support research on devices or gear modifications to reduce bycatch of regulated or protected species.
- Conduct studies to evaluate effects of gears on habitats.
- Support development of devices to reduce protected species impacts on aquaculture.
- Develop improved gears for collection of fishery-independent data
- Study bycatch of finfish in mobile gear and identify bycatch reduction alternatives.
- Study seabird entanglement by commercial fisheries in the Northwest Atlantic Ocean.
- Provide assistance in the development and design of fish passage facilities at hydro electric projects and other river barriers to minimize adverse impacts on the migration of anadromous and catadromous fish.
- Collect information on interactions between fishing gear and endangered whales and develop modifications to gear that will minimize impact to allow fishing to continue.

III. Research on Fisheries

A. Social and economic research

- Evaluate biological and social and economic consequences of alternative management strategies, e.g., ITQ or other allocation-based approaches.
- Research overcapitalization and describe and model harvesting and processing sectors.

B. Full utilization of harvested fish

- Evaluate the contamination of seafood with metals and chlorinated hydrocarbons such as PCBs, pesticides and dioxins.
- Develop hydroacoustic capabilities for pelagic fish stock assessment.
- Determine impacts of protected species on fishery resources.
- Determine ecosystem responses to reduced harvesting.

C. Mariculture

- Develop modern technology for the aquaculture production of finfish and shellfish using intensive, extensive and land-based recirculating systems strategies.
- Develop techniques for stock enhancement/restoration of shellfish and finfish in areas that historically supported a wild fishery, but are not now productive or may have reduced stocks.

IV. Information Management Research

- Develop methods for greater access to data and information using web-based technologies.
- Inclusion of all species of interest to NMFS on the Internet in ITIS--the Integrated Taxonomic Information System. This interagency effort by NMFS and National Oceanographic Data Center (NODC) in NOAA with Environmental Protection Agency (EPA), U.S. Department of Agriculture (USDA), U.S. Geological Survey (USGS), Biological Resources Division of USGS (BRD), and the Smithsonian Institution replaces the NODC Taxonomic Code. The 400,000 names contained in the NODC Code have been moved to ITIS. Review, editing and adding names are underway.
- Completion of U.S. Marine Biodiversity Database (MARBID) --a system to measure changes in biodiversity through time and space by integrating fishery survey data with museum collection's data. (Supported with Environmental Sciences Data Information Management [ESDIM] funds, starting with the NEFSC databases as a pilot project)

- Development of methods to archive, database, and present multimedia information such as videotapes recorded in situ. The emphasis of the current project is on cephalopods. (In cooperation with the Smithsonian Institution)
- Improve data entry and archiving procedures for data collected on bottom trawl and scallop and shrimp surveys.
- Audit and finalize age data files and biological data collected during resource surveys; maintain and modify age data building system.
- Investigate striped bass tagging databases using GIS and statistical models.
- Develop and implement regional data dictionary system to aid in description and dissemination of data.
- Develop DODS (Department of Defense Standard) compliant client and server libraries to support Internet access to NODC Oceanographic data sets.
- Investigate new data collection technologies with the purpose of improving collection and processing efficiency.
- Within ACCSP process, improve data collection and management for commercial and recreational fisheries.

APPENDIX B: Response to Comments on Public Draft of the NMFS Strategic Plan for Fisheries Research

In October 1997 NMFS published a Notice of Availability in the Federal Register announcing the availability of the draft Strategic Plan for Fisheries Research. Comments were received by 12 organizations and individuals representing a range of interests from conservation organizations to fishing industry associations to fisheries management councils and state management agencies. The comments were very helpful in revising the plan and preparing the final document. This appendix summarizes the comments and addresses each major comment. Many commenters also identified inconsistencies in the draft plan and suggested editorial or textual changes. These specific comments are not addressed here. However, the final plan document incorporated these suggestions as much as possible.

Comment: Several commenters suggested that the Sustainable Fisheries Act (SFA) mandate for the Strategic Plan for Fisheries Research to “provide a role for commercial fishers in research, including involvement in field testing” was not sufficiently addressed in the Plan. Specifically, commenters remarked that the Plan cites various pre-existing and ongoing activities involving commercial fishers, but none of the major fishery research goals and objectives directly outline participation of commercial fishers in research and field testing.

Response: NMFS agrees. The document has been revised to reflect NMFS’ commitment to external partnerships by adding a goal and objectives focusing on providing a role for commercial and recreational fishers as well as other groups to work collaboratively on research including field testing. Other objectives already listed in the Plan are a subset of those listed in the *NOAA Fisheries Strategic Plan* (FSP). Objective 2.6 (FSP Objective 3.4.2) directly addresses this issue where fishing industry includes commercial fishers. Additionally, under Appendix A: NMFS Scientific Enterprise, the Strategic Plan for Fisheries Research already cites examples of major collaborative research initiatives focused on the needs of the fisheries industry, including commercial fishers.

Comment: Commenters stated that this Plan should utilize fishing vessels in actual harvest mode for survey collection.

Response: This Plan addresses involving constituents in research programs under “Goals of the Scientific Enterprise”. To the extent practicable, NMFS will charter fishing vessels to participate in research projects. For example, as cited in this Plan, NEFSC has utilized private fishing vessels to support ecosystem surveys. All other Centers also use

commercial vessels in conducting certain surveys. Fishers also received grants to carry out gear research.

Also, this Plan states that to the extent practicable, NMFS will develop methods to incorporate scientifically valid observations by fishers and others into fish stock assessments and other analyses related to living marine resources and their habitat.

Comment: Commenter remarked that the discussion of ecosystem-based research in this Plan lacked sufficient detail and needs to go further so that the effects of fishing on a spectrum of predators and prey could be predicted.

Response: NMFS agrees. The continued development of ecosystem-based research is necessary and we have added language describing ecosystem-based research as a basis for improving management of living marine resources. It is important to note that in developing the research program to implement this approach more fully, NMFS is faced with existing demands on research based on species-specific management plans and measures. Therefore, this Plan reflects a transition from single species to ecosystem-based research. For example, NMFS' research efforts on stock assessments have been evaluated in a recent independent report by the National Research Council (NRC). The NRC Committee on Fish Stock Assessment Methods believes "that single-species assessments provide the best approach at present for assessing population parameters and providing short-term forecasting and management advice. Recent interest in bringing ecological and environmental considerations and multi-species interactions into stock assessments should be encouraged, but not at the expense of a reduction in the quality of stock assessments."

Comment: Commenter suggests that this Plan does not adequately address other life history characteristics that influence fish stocks such as conditions that may be necessary for species to spawn.

Response: NMFS agrees. NMFS recognizes the complexity of ecosystems and the need to examine all the diverse components. Section I.A. "Biological research concerning the abundance and life history parameters of fish stocks" has been revised to reflect NMFS' research activities in this area more accurately.

Comment: Several commenters state that the discussion of adaptive/experimental management as a research tool be presented in the Plan. Additionally, commenters remarked that discussion on research closure areas is limited to the effects of trawling and studies should be expanded to no-take marine reserves for more comprehensive research. Furthermore, the establishment of no-take marine reserves should be included to successfully implement EFH provisions of the Magnuson-Stevens Act.

Response: NMFS agrees and has included language on adaptive/experimental management research including the identification and use of potential areas of refugia (i.e., research closure areas) and experiments on no-take and limited-take zones and time-area closures.

Comment: Several commenters suggested an integrated expansion on social and economic research, particularly research into economic incentives.

Response: NMFS agrees. This Plan has been revised to reflect NMFS' coordinated economic and social analyses that will be required under new provisions of such laws as the Magnuson-Stevens Act and the Regulatory Flexibility Act. Appropriate modifications have been made through the document, particularly under Section III.A. "Social and economic research".

Comment: Commenter suggests that the Plan directly address social and economic research on tourism and non-consumptive recreational benefits.

Response: Although NMFS agrees that it is important to examine tourism and non-consumptive recreational benefits, the Plan does not attempt to list or describe everything we would like to do. NMFS has attempted to include only those research efforts that NMFS believes it will have funding to carry out.

Comment: Commenter suggested that this Plan should examine the potential impacts of international trade agreements upon United States fisheries --impacts which affect not only United States competitiveness in the short term, but the fisheries themselves over the long term, as well as the sustainability of U.S. consumption of fisheries products.

Response: NMFS agrees. Section III.A. of this Plan states that NMFS will conduct research to determine how trade agreements impact our Nation's competitiveness. For the long term, NMFS is required to maintain U.S. fisheries at or above the level that would support the maximum sustainable yield on a continuing basis and recognizes that trade liberalization could create an environment where overfishing occurs. NMFS is currently engaged in discussions to address this second concern.

Comment: Commenter recommends that Section III.C. on marine aquaculture be modified away from a "pro-development posture" until it is clear which government agency has authority to regulate marine aquaculture in the U.S. EEZ.

Response: Aquaculture is considered a fishery, as defined by the Magnuson-Stevens Act and is relevant to NMFS' fisheries research activities. Section III.C. of this Plan only establishes NMFS' rationale for marine aquaculture as a research component and

addresses the issues of mariculture. Although the Army Corp of Engineers currently has authority to permit mariculture in the U.S. EEZ, the NMFS can block the permit during the consultative process if there is an indication that the operation would undermine the MMPA, ESA or adversely impact LMRs or EFH.

Comment: Commenter suggested that the tools for fishery independent data collection are outdated and a new fleet of research vessels with the latest assessment technologies are needed. This Plan fails to include an explicit strategy for acquiring fishery-independent data.

Response: Although NMFS agrees that there is a need for new research vessels, this Plan is not the appropriate forum to forward this concern.

Comment: Several commenters proposed specific changes to objectives listed in this Plan.

Response: The objectives found in this Plan are taken directly from the *NOAA Fisheries Strategic Plan* (FSP). Any changes would have to be made in the latter. We will consider these changes during the revision of the FSP.

Comment: Several commenters remarked that the Plan was very comprehensive and it recognized the need to broaden fisheries research. Commenters also noted that the document appropriately outlined the direction of future work.

APPENDIX C: ABBREVIATIONS AND ACRONYMS

ABL	Auke Bay Laboratory
ACCSP	Atlantic Coastal Cooperative Statistics Program
AFSC	Alaska Fisheries Science Center
AKFIN	Alaska Fisheries Information Network
ASMFC	Atlantic States Marine Fisheries Commission
BRDs	Bycatch reduction devices
BRD(USGS)	Biological Resources Division (USGS)
CAFF	Conservation of Arctic Flora and Fauna
C-CAP	Coastal Change Analysis Program
ComFin	Commercial Fisheries Information Network
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CPUE	Catch-per-unit-of-effort
DNA	Deoxyribonucleic acid
DODS	Department of Defense Standard
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESDIM	Environmental Sciences Data Information Management
FAO	Food and Agriculture Organization of the United Nations
FMC	Fishery management council
FMP	Fishery management plan

FSP	NOAA Fisheries Strategic Plan
FTE	Full-time equivalent
GIS	Geographic information systems
GLOBEC	Global Ecosystems Dynamics
GOOS	Global Oceans Observing Program
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICES	International Council for the Exploration of the Seas
IOCARIBE	International Oceanographic Commission for the Caribbean
IPCC	Intergovernmental Panel on Climate Change
ITIS	Integrated Taxonomic Information System
ITQ	Individual Transferable Quota
LME	Large marine ecosystem
LMR	Living marine resource
MAFMC	Mid-Atlantic Fishery Management Council
MARBID	Marine Biodiversity Database
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
NEFMC	New England Fishery Management Council
NEFSC	Northeast Fisheries Science Center
NERO	Northeast Regional Office
NGO	Non-government organization
NMFS	National Marine Fisheries Service
NMML	National Marine Mammal Laboratory
NOAA	National Oceanic and Atmospheric Administration
NODC	National Oceanographic Data Center
NRC	National Research Council

NWFSC	Northwest Fisheries Science Center
PacFIN	Pacific Fisheries Information Network
PICES	North Pacific Marine Science Organization
RACE	Resource Assessment and Conservation Engineering Division
RecFIN	Recreational Fisheries Information Network
REFM	Resource Ecology and Fisheries Management Division
SARC	Stock Assessment Review Committee
SAW	Stock Assessment Workshop
SEFSC	Southeast Fisheries Science Center
SFA	Sustainable Fisheries Act of 1996
SWFSC	Southwest Fisheries Science Center
TED	Turtle Excluder Device
USDA	United States Department of Agriculture
USGS	United States Geological Survey

APPENDIX D: GLOSSARY

Adaptive Management - A combination of stock assessments with prior knowledge of the fishery coupled with quantitative modeling and empirical management experimentation.

Anadromous - fish which spawn in freshwater, but spend most of their life in salt or brackish water.

Benthic - refers to organisms which live at or near the bottom (see Demersal)

Broodstock - adult fish used to propagate the subsequent generation of hatchery fish.

Bycatch - the Magnuson-Stevens Fishery Conservation and Management Act defines *bycatch* as “fish which are harvested in a fishery, but which are not sold or kept for personal use, and includes economic discards and regulatory discards... [But not] fish released alive under a recreational catch and release fishery management program.

Bycatch reduction device (BRD) - any of a number of implements that have been certified to reduce the likelihood of capturing non-target species.

Catadromous - fish which spawn in saltwater but live most of their life in freshwater.

Catch per unit effort (CPUE) - the amount of fish that is caught by a given amount of effort. Typically, effort is a combination of gear type, gear size, and length of time the gear is used.

Charter fishing - fishing from a vessel carrying a passenger(s) for hire; who is engaged in recreational fishing.

Commercial fishing - fishing in which the fish harvested, either in whole or in part, are intended to enter commerce or enter commerce through sale, barter, or trade.

Commercial fisheries information network (ComFIN) - a cooperative state-Federal effort among marine fisheries agencies to improve collection and management of commercial fisheries statistics.

Conservation engineering - the practice of determining the modification in gear design that will meet conservation objectives, such as decreasing bycatch and bycatch mortality by increasing the selectivity of gear and increasing the survival of fish and other living marine resources that fishing gear encounter inadvertently.

Continental shelf - the seabed and subsoil of the submarine areas adjacent to the coast, but outside the area of the territorial sea, of the United States, to depth of 200 meters or, beyond that limit, to where the depth of the superjacent waters admits of the exploitation of the natural resources of such areas.

Demersal - fish and animals that live near the bottom of an ocean.

Essential fish habitat - the Magnuson-Stevens Fishery Conservation and Management Act defines *essential fish habitat* as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.”

Endangered Species - a species is considered “endangered” if it is in danger of extinction throughout a significant portion of its range; it is considered “threatened” if it is likely to become an endangered species.

Endangered Species Act (ESA) - The Federal law, enacted by Congress in 1973, to provide protection for, and promote recovery of, animal and plant species considered as threatened or endangered because of natural or anthropogenic conditions.

Exclusive economic zone (EEZ) - the zone contiguous to the territorial sea of the United States, the inner boundary of which is a line coterminous with the seaward boundary of each of the coastal states and the outer boundary of which is a line drawn in such a manner that each point on it is 200 nautical miles from the baseline from which the territorial sea is measured. This zone was established by Proclamation Numbered 5030, dated March 10, 1983.

Ex-vessel value - the amount paid to vessel’s owner or operator for its catch, excluding any value added by at-sea processing.

Fishery management council (FMC) - one of eight regional groups established under Section 302 of the Magnuson-Stevens Fishery Conservation and Management Act to prepare and oversee fishery management plans for fisheries conducted principally within the exclusive economic zone.

Fishery management plan (FMP) - a plan developed by a regional fishery management council, or the Secretary of Commerce under certain circumstances, to manage a fishery resource in the U.S. EEZ pursuant to the Magnuson-Stevens Fishery Conservation and

Management Act. Includes data, analyses, and management measures for a fishery.

Gillnet - a flat net suspended vertically in the water used to capture fish which entangle themselves in the net, usually by the forward part of the body near the gills.

Groundfish - a species of fish, usually finfish, that live on or near the sea bottom part of the time.

Juvenile - a young fish, usually resembling an adult in appearance, but which has not yet become sexually mature; usually applied to fish less than one year old.

Krill - small abundant crustaceans that form an important part of the food chain in Antarctic waters.

Marine Mammal Protection Act (MMPA) - the MMPA is a statute which was enacted in 1972 to protect marine mammals and their habitat. These species include whales, dolphins, seals, seal lions, walruses, and many others.

Plankton - Plants (phytoplankton) and animals (zooplankton) which float in the upper portion of the water column and provide the basic constituents of the oceanic food web. Most planktonic organisms are microscopic in size. Eggs and larvae of many fisheries species are also components of the plankton community.

Population - a group of interbreeding organisms generally inhabiting a given geographic area.

Quota - the maximum amount of fish that can be legally landed in a time period. It can apply to the entire fishery, an individual fisher's share under an individual fishing quota (IFQ) system, or reference to the size of fish.

Recreational fisheries information network (RecFIN) - a cooperative state-Federal effort among marine fisheries agencies to improve collection and management of marine recreational fisheries statistical information.

Recruitment - a measure of the weight or number of fish which enter a defined portion of stock, such as the fishable stock or the spawning stock.

Saltonstall-Kennedy (S-K) grant program - a competitive program that provides funds through grants or cooperative agreements for research and development projects to benefit U.S. fishing industry. The S-K Act, as amended [15 U.S.C. 713 (c) (3)] is the program's statutory authority.

Stakeholder - one who is expected to receive economic or social benefits from the conservation and management of living marine resources.

Stock assessment - the biological assessment of the status of the resources. This analysis provides the official estimates of stock size, spawning stock size, fishing mortalities, recruitment, and other parameters.

Stock assessment workshop (SAW) - a cooperative stock assessment activity in which scientists from various agencies evaluate the status of fish stocks.

Subadult - a developmental life stage when fish exhibit most but not all traits of an adult fish.

Subsistence fishing - fishing for personal consumption or traditional/ceremonial purposes.

Turtle excluder device (TED) - an implement that has been certified to reduce the likelihood of capturing turtles.

Virtual population analysis - a method of estimating stock size through examination of sizes of individual age classes (cohorts), growth, and mortality rates.

