

# Our Nation's Fisheries: A Proud and Troubled Heritage



*"A few years ago, in view of the enormous abundance of fish originally existing in the sea, the suggestion of a possible failure would have been considered idle; and the fisheries themselves have been managed without reference to the possibility of a future exhaustion. The country has, however, been growing very rapidly. . . . The object of those engaged in the fisheries has been to obtain the largest supply in the shortest possible time. . . ."*

Those words present a fairly accurate picture of the state of America's marine fisheries. A Washington bureaucrat who, like many, wanted to resolve what he saw as a looming national problem wrote them. While the words could have been written within the last few years, they were, in fact, the words of Spencer F. Baird, the founder of the United States Fish and Fisheries Commission in 1871 and its first commissioner. As we enter the 21st century, many of the issues Baird recognized are still with us. They are exacerbated by issues that Baird never imagined — endangered species, bycatch reduction, habitat loss and conflicts between commercial and recreational fishermen, to name but a few.

# Addressing fisheries issues in the modern era



Many of our nation's marine and Great Lakes fisheries are in trouble. The New England cod fishery has collapsed, Columbia River salmon are being listed as threatened or endangered, while Atlantic salmon populations on the East coast continue to decline. Pacific salmon support a multi-billion dollar recreational fishing industry in the Great Lakes, but are threatened by ecosystem changes likely caused by recent introductions of aquatic nuisance species. 🌐 The United States has made a concerted effort at the federal level over the past 130 years to find ways of maintaining the nation's marine and Great Lakes fisheries, and many of those efforts have been successful. Responding to mandates contained in the Magnuson Fisheries Conservation and Management Act of 1976 (now the Magnuson-Stevens Fisheries Conservation and Management Act), regional fishery management councils were established that developed management plans for most commercially and recreationally valuable species. In recent years, the need to identify and protect essential fish habitat has been added to the provisions of the Act, leading fisheries managers to begin discussing management on the basis of communities of organisms, not just single species. The world of fisheries management has become increasingly complex, yet after more than a century and a quarter, information is still not fully available to manage fisheries on a sustainable, environmentally friendly, yet economically sound basis. 🌐 The issues are large, and solutions are needed. The time required to achieve those solutions can be reduced through development of an aggressive research and outreach effort through the National Sea Grant College Program of the National Oceanic and Atmospheric Administration (NOAA). Sea Grant mobilizes the scientific, outreach and educational resources available on more than 300 college campuses to address the issues and provide information upon which policymakers can act. Information can also be provided in a form understandable to the public. 🌐 Sea Grant Programs located in all of the coastal and Great Lakes states pride themselves in being objective sources of timely scientific information. Furthermore, Sea Grant investigators and outreach personnel will continue to partner with scientists in NOAA's National Marine Fisheries Service (NMFS) and in state natural resource agencies to avoid duplication of effort, combine talent and focus on the most critical issues.

# Established record of accomplishment

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Sea Grant is not a newcomer to fisheries research and outreach. Sea Grant was established more than 30 years ago as a program focused on the wise use and conservation of marine resources, with one of the most important of these being marine and Great Lakes fisheries. As Sea Grant has matured and expanded its network of investigators, what was once largely a program focused on biology has spread to engineering, modeling, oceanography, economics and the social sciences. With regard to fisheries, Sea Grant research and outreach activities have increasingly involved recreational angling while in no way ignoring the problems faced by the commercial fishing sector. 🎣 The list of Sea Grant research and outreach accomplishments associated with fisheries is long. The following are a few examples of Sea Grant fisheries activities since 1995:

- Researching the impacts of and assisting the commercial shrimp fishing community in the deployment and use of turtle excluder devices (TEDs) and bycatch reduction devices (BRDs).
- Conducting research to evaluate essential fish habitat through a variety of techniques including determination of food web dynamics, habitat modeling, larval transport from spawning grounds to nursery areas and identification of optimal nursery ground conditions.
- Studies on recruitment of commercial and recreational species into marine and Great Lakes fisheries.
- Evaluation of short- and long-term climate change on fish distribution and abundance.
- Evaluation of the usefulness of harvest refugia as a management technique.
- Examination of the legal and economic ramifications of various fisheries management plans.
- Evaluation of the impacts of fishery regulations on fishing communities.
- Population dynamics of various species of commercial and recreational importance.
- Bioeconomic analyses of various aquatic species.
- Examination of stock enhancement as a means to help recover depleted fishery resources.





## Resource needs

Sea Grant can make significant progress in addressing the research and outreach initiative identified in this booklet if increased funding is made available. It is estimated that a funding level of at least \$12 million per year for five years (\$60 million total) would be required for this purpose.

## Scope of the nine-part initiative

This initiative addresses fisheries issues in nine areas. Each topic, to a certain extent, is self-contained. In reality, however, the nine topics contain various threads that will ultimately be woven together into a research and outreach tapestry capable of providing the nation with the information required for managing fisheries in an environmentally sensitive, economically sound and sustainable manner.

Various components of the tapestry are currently in place as a result of the research and outreach activities conducted through Sea Grant and other entities, including state and federal natural resources agencies. This initiative will build upon that existing body of knowledge. In developing this initiative, the current information has been examined and the priority research and extension needs have been identified. Those needs, and the approaches to be employed by Sea Grant to meet them, are outlined in the pages that follow.

# Advanced sampling technology



*Fisheries managers must know how many fish are in the water, where they are located, how different species interact with each other and their habitats and how changes in the environment affect the animals. 🌐 Sea Grant researchers and outreach specialists will work with fishermen and other concerned parties to test new sampling technologies and pioneer analytical procedures that will lead to more accurate estimates of distribution and abundance of fish and invertebrates, broaden understanding of how the animals interact with their environments and what habitats are best for different species, and how changes in the environment affect fisheries.*

A recent National Research Council report (NRC 1998) recommended the availability of at least one reliable fishery-independent abundance index for every managed stock. Fully implementing this recommendation would require assessing hundreds more stocks than at present, a nearly impossible task given existing technology, personnel and funding.

Estimates of stock abundance and recruitment are key elements to a stock assessment and are based on fishery-independent surveys coupled with fishery statistics. The direct counting of animals in the sea or the Great Lakes is an inexact science because of limitations in technology and ship time. Traditional research vessel surveys possess inherent biases that confound the ability of scientists to accurately estimate abundance of all life stages.

Environmental conditions also play a key role in estimating stock abundance. The precision of survey-based abundance estimates can be improved, costs reduced or coverage expanded if the likely distributions of animals can be predicted through modeling of fish habitat selection and biological-physical interactions or using advanced spatial characterization techniques, and if

adaptive sampling is employed. Environmental measurements can also be incorporated into a geostatistical sampling design to improve precision and are needed to establish the link between stock dynamics, distribution, movements and environmental forcing.

## Research Needs

Advances in sampling technology are needed to measure and monitor marine animal stock abundance with the greatest possible statistical precision, lowest survey cost and minimal bias. These improvements can be achieved with advanced sensing technologies, improved design and deployment of sampling instruments, new models and the merging of new technologies in physical and biological sampling. Areas for research include:

- Hydroacoustics: The conversion of acoustic targets to biomass and the assignment of species to targets need to be addressed.
- Lidar: Airborne LIDAR (Light Detection and Ranging) technology has the same problems as hydroacoustics. The technology must be adapted to fishery survey needs, and detection and data processing algorithms are needed for implementation.
- Submersibles: Advanced technology is needed to reduce survey costs and to combine digital camera and acoustic systems to rapidly and accurately process the combined data.
- Passive acoustics: Fixed or towed hydrophone arrays could be effective in measuring the abundance of marine mammals and some species of fish.
- Deployment strategies: Work is needed on the overall efficacy and relative accuracy of



sampling instruments such as mobile towed vehicles, mobile autonomous vehicles, fixed deployments and on appropriate spatial and temporal scales of sampling and analysis.

- Mixed survey technologies: Work is needed on survey model and sampling design emphasizing temporal/spatial scales with mixed technologies.
- Underway sampling: Technologies are needed that can enhance or supplant shipboard monitoring at fixed grid points and provide a continuous record of environmental variables to accompany continuous records of abundance provided by underway fish sampling techniques.
- Other areas of advanced sampling technology requiring development:
  - ◆ Electronic fishing vessel logbooks,
  - ◆ Vessel monitoring systems,
  - ◆ Marine mammal monitoring in polar seas,
  - ◆ Archival and telemetering tags to define movements and responses of individual animals to their habitat,
  - ◆ Reduction of bias in acoustic trawl surveys due to fish avoidance.

## The Role of Sea Grant

The Sea Grant network can best participate in addressing the above research needs through collaboration by university researchers with colleagues in interested Federal agencies such as the NMFS Fisheries Science Centers, Oceanic and Atmospheric Research (OAR) Laboratories and Joint Institutes and the OAR National Undersea Research Program.

# Stock enhancement

*Enhancement of declining fish populations by producing fish for stocking in marine coastal areas or in the Great Lakes has been successful in some instances and could augment existing management strategies. The approach should ensure that enhanced animals do not negatively affect the genetic diversity of natural populations and should lead to the determination of how many cultured animals can be added to an area without adversely affecting naturally occurring organisms of the same or different species. 🌊 Sea Grant researchers, working in concert with other groups of scientists, will assess how fish released from aquaculture facilities interact with other species in the wild and determine how extensively hatchery fish interbreed with their wild cohorts. Researchers also will study how to minimize effects of aquaculture wastes on water quality and how market competition between cultured fish and wild-caught fish affects the seafood industry.*

Large-scale marine and Great Lakes aquaculture in the United States dates back to stocking programs with cultured fishes and invertebrates that were initiated soon after the United States Fish and Fisheries Commission was established in 1871. Part of Spencer F. Baird's incentive to lobby Congress for establishment of the Commission was his recognition that many of the nation's commercial fisheries were in decline.

Within a few years of being appointed commissioner, Baird established hatcheries on the East and West coasts as well as on the Great Lakes. Atlantic and Pacific salmon, shad, cod, walleye, lobsters and various other species were spawned, hatched and





stocked. Many attempts at establishing fish in new locations failed, though there were some successful introductions including striped bass in California, rainbow trout east of the Cascade Mountains and brown trout in various locations.

Enhancement efforts in marine waters, with the exception of salmonids, were curtailed in the early part of the 20th century. In the interim, particularly beginning in the 1960s, aquaculture technology has advanced to the point where significant numbers of fish and invertebrate species can now be successfully reared in hatcheries to sizes that have a much better probability of survival than was the case previously. Successes associated with enhancement of salmon in Alaska, shellfish in many coastal waters, striped bass along the Atlantic coast and red drum in Texas provide evidence that enhancement deserves further consideration as one of several methods to help restore depleted fish stocks.

### Research Needs

The overall goal of an enhancement program would be to ensure that stocking is conducted in an environmentally sound manner. The focus of the research will be to:

- Ensure the maintenance of genetic diversity within cultured populations.
- Determine the carrying capacity of the environment for the introduced species.
- Determine if stocked fish assume the same behavioral patterns as wild fish (this would include determining if stocked and wild fish interbreed).
- Determine the percentage of enhancement animals that recruit to the commercial and recreational fisheries.

## The Role of Sea Grant

Sea Grant has implemented a National Strategic Initiative in aquaculture that provides the framework for partnerships among Sea Grant investigators and outreach personnel, private industry and state and federal agencies to develop research and demonstration facilities for producing aquatic species to be reared in captivity or released for enhancement. This fisheries initiative would add the environmental research component to that earlier initiative by mobilizing the environmental scientists and geneticists in the Sea Grant network, along with developing cooperative arrangements with state natural resources agencies and NOAA line offices.



# Essential fish habitat



*Human activities can degrade fisheries habitat, and natural environmental changes affect habitat in other ways. Little is known about the kinds and quality of habitat fish and invertebrates require throughout their lives, how habitat affects fishery production and how human activities and natural environmental changes affect habitats. 🌊 To help fill the knowledge gaps, Sea Grant scientists will synthesize what is known about estuarine and marine habitats and their importance to the animals that depend upon them, examine how human activities, natural hazards and environmental change affect fisheries, and find effective ways to restore and enhance degraded habitat.*

Habitats important to stocks of finfish and shellfish species exist in riverine, estuarine, coastal and offshore continental shelf waters within the United States Exclusive Economic Zone (EEZ) as well as in waters of the Great Lakes. A long-term threat to the viability of commercial and recreational fisheries is the continuing adverse impact of various human activities and natural hazards on our marine and Great Lakes aquatic habitats.

The Magnuson-Stevens Fishery Conservation and Management Act, through the Sustainable Fisheries Act, mandated the identification of habitats essential to federally managed marine finfish and shellfish species and the identification of measures to conserve and enhance those habitats. Essential fish habitat (EFH) was defined as “those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity.” This has been further interpreted by NOAA to include aquatic areas and their associated physical, chemical and biological properties needed to support sustainable fisheries and healthy ecosystems involving managed species.

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The eight regional fishery management councils have amended their fishery management plans for coastal and marine species to: (1) describe and identify EFH for all life stages of managed species; (2) provide information on fishing and non-fishing activities that may adversely impact EFH; (3) recommend measures to conserve and enhance EFH; and (4) minimize, to the extent practicable, adverse impacts on EFH caused by fishing activities.

Although the EFH mandate of Congress was directed toward federally managed fisheries, it has served to heighten awareness and stimulate similar efforts by state resource agencies and interstate marine fisheries commissions responsible for near-shore and estuarine waters and by state, federal and international bodies responsible for Great Lakes waters.

## Research Needs

There are large gaps in knowledge regarding habitat preferences and requirements of the life stages of many finfish and shellfish species, the role played by various habitats in the fishery production process and the impacts of various anthropogenic and natural activities on habitat structure and function. In order for the relevant entities responsible for marine or Great Lakes waters to adequately manage habitats, these gaps in knowledge must be filled through expanded research and extension efforts.

Critical and high priority problems related to fisheries habitat issues of regional or national importance in United States coastal and Great Lakes waters toward which research under this initiative will be conducted include:

- Identification, quantification, synthesis of existing information and understanding of the linkage between fisheries and their habitats.
  - ◆ Completion of life history inventories of managed species.

- ◆ Determination of habitat factors influencing distribution, abundance, growth, species interactions and survival for prediction of fisheries abundance trends and yields.
- ◆ Development of conceptual ecosystem models and their functional attributes incorporating habitat.
- ◆ Establishment and quantification of linkages between habitat and fisheries production.
- Determination of the effects of anthropogenic activities, such as fishing, aquaculture and stock enhancement, point and non-point source pollution and coastal and urban development, on the habitat of managed fisheries.
- Determination of the impacts of natural hazards, such as global climate variation and storms, on fisheries habitat.
- Examination of the effects of restoring habitat including activities such as artificial reef building, estuarine dredging, establishment of marine reserves, wetland rehabilitation, shoreline and streambank stabilization and spawning habitat rehabilitation.

## The Role of Sea Grant

University researchers and extension personnel within the 30 university-based Sea Grant programs and their more than 300 institutions, in collaboration with colleagues in state, federal and private agencies and organizations, have a demonstrated capability, capacity and interest to immediately launch a diverse array of research and outreach activities aimed at filling gaps in scientific knowledge and applying the results for the benefit of stakeholders.

# Fisheries oceanography

*Fisheries oceanography is the science of understanding and predicting the effects of ocean and atmospheric processes on marine ecosystems. It demands the integration of many scientific disciplines and is critical to effective fisheries management.  Multidisciplinary teams of researchers will be required to develop techniques to detect and forecast climate and ecosystem (regime) changes that occur in ocean basins over decades. They will examine how these changes affect all levels of sea life. This work will help managers and scientists more accurately predict changes in ecosystems.*



The overall goal of fisheries oceanography is to understand and predict the effects of ocean and atmospheric processes at varying temporal and spatial scales on marine ecosystems and resources. Operational fisheries oceanography is largely interested in how ocean processes influence fish distribution, availability, recruitment and abundance and how they impact fisheries and their management.

A specific goal is to understand the natural causes of variability in year-class strength of harvested fish species and apply that knowledge to management. Factors such as temperature, nutrient enrichment, concentration of organisms and transport of organisms are some of the physical mechanisms affecting fluctuations of marine resources. Research to investigate the intervening processes must be interdisciplinary and requires expertise in physical and biological oceanography, meteorology, climatology, fisheries science and ecology.

Research in fisheries oceanography can be conducted at different temporal and spatial scales. Small- and meso-scale (process-oriented) work pertains to physical and food-chain processes

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over relatively short time scales. Regional-scale work examines processes that impact the interannual variability in populations, while large-scale work is basin-wide to global. Since global climate variability impacts regional ecosystem dynamics, the spatial domain often must be expanded. Observational data and modeling are key elements in all of these scales.

### Research Needs

Climate and ecosystem changes (regime shifts) on decadal and basin temporal and spatial scales occur rapidly as climate system components realign themselves. Such shifts are significant for fisheries management. Climate-ecosystem linkages can be established through ecological observations leading to time series of biological and physical indicators. Comprehensive sets of indicators, except for fishery-independent surveys, fishery catch statistics and biological sampling of catches, do not exist for any marine ecosystems, and available time series of biological data are, for the most part, incomplete in time and space.

Numerical modeling to simulate physical and biological processes (i.e., recruitment variability, compensatory mechanisms and species interactions) that control the abundance of living marine resource populations occurring at larger temporal and spatial scales is progressing more rapidly than the data needed for input and to evaluate output. Diagnostic physical and biological ecosystem models will have to identify principal modes of ecosystem variation and leading indicators of future regime shifts. These models will help quantify ecosystem responses to climate change, climate variability and harvest levels from fisheries.

Research in fisheries oceanography will be designed to:

- Fill the information gaps on climate-ecosystem linkages through increased ecological observations leading biological and physical time series.

- Develop increased cost-effective monitoring of physical and biological systems on appropriate scales coupled with the development of proxy indicator time series.
- Develop diagnostic physical and biological ecosystem models that examine ecosystem variation and indicators of future regime shifts.
- Conduct further studies to understand and discriminate between cause and effect represented by ecological indicators.
- Investigate the scientific bases for defining policy issues relative to climate-driven environmental change and fisheries resource use in the long term and at global scales.



## The Role of Sea Grant

Interdisciplinary, interagency and international collaboration will be required to satisfactorily address the broad-scale research needs on the impact of environmental processes on living marine resources that have been and will be identified. Participation by Sea Grant researchers in all such endeavors will bring in additional disciplines and personnel to address these major issues.

# Great Lakes fisheries



*The five Great Lakes hold about 20 percent of the world supply of fresh water and about 95 percent of the United States freshwater supply. The Lake Erie commercial fishery is the largest freshwater commercial fishery in the world, and the Great Lakes support large recreational fisheries. Well-informed management is critical in this highly populated and environmentally sensitive region. 🌐 Sea Grant researchers have been involved in the Great Lakes for more than 30 years. Sea Grant research and outreach programs have been a major source of information for managers and the public on some of the emerging issues such as invasive aquatic species.*

Approximately 30 percent of the United States population lives in the Great Lakes region. The total shoreline, which is longer than the Atlantic, Gulf of Mexico or Pacific coasts, is characterized as highly developed and urbanized as well as very remote and undeveloped. The lakes themselves are equally diverse, ranging from the large, cold, and deep (410 m) Lake Superior to the shallow (65 m) and warm Lake Erie.

Water temperature and nutrient enrichment largely determine fishery productivity in the Great Lakes. The southernmost lake, Erie is also the warmest with summer temperatures in the western basin often reaching 26°C. With the exception of Lake Erie, the watersheds around the Great Lakes are dominated by forest ecosystems. The other lakes are deep, cold and clear and support primarily coldwater fisheries where a variety of salmonids are harvested. The watershed around Lake Erie is primarily agricultural and urban. As a result, it receives more nutrients and sediment loading than the other lakes, is the most productive biologically and supports primarily cool water forms dominated by fishes in the perch and sunfish families. Management of the system requires

cooperation and coordination among eight states and the province of Ontario, two countries and a number of Native American nations.

The Great Lakes have been intentionally stocked as well as invaded by scores of aquatic species over the past century. Establishment of the salmoid sport fishery through intentional stocking represents a success story. Unanticipated and unwanted invasions by such species as the sea lamprey, zebra mussel and Eurasian ruffe have led to ecological disasters and extracted a heavy economic price in the region.

Lake Erie has the largest freshwater commercial fishery in the world, much of which is located primarily on the Canadian side. That fishery has declined drastically in recent years. The commercial fishery in the region competes with a very large charter boat fishery (more than 2,000 licensed captains) and a large sport fishery. The fisheries on some of the lakes are maintained only with extensive stocking programs, while natural reproduction dominates on others.

## Research Needs

Great Lakes research under this initiative will focus on:

- Developing appropriate management strategies to accommodate both the growing sport fisheries and the existing commercial fisheries.
- Developing and linking improved biological and physical ecosystem models.
- Developing bioenergetic models, with particular emphasis on modeling the base of the food chain.
- Determining the ecological and economic impact of the more than 140 aquatic nuisance species that have colonized the Great Lakes region.



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- Developing management strategies to stop the spread of Eurasian ruffe in the Great Lakes.
  - Finding methods to control other current aquatic nuisance species and preventing the invasion of new ones.
  - Improving our understanding of contaminant transfer across trophic levels and within the system and understanding the sublethal impacts of contaminants on fish.
  - Determining the impact of habitat alteration and loss on fish and how socio-economic policies impact land-use activities.

### The Role of Sea Grant

Sea Grant's role on all of these issues will be to perform research and to collaborate with the management community on research to address the identified issues. Sea Grant will also assist in communicating with decision-makers and non-scientists to make these complex scientific issues understandable. A number of organizations have identified a shortage of highly trained limnologists and fishery managers to replace an aging workforce. Clearly, training new scientists and managers is an area where Sea Grant can play a leadership role.

# Harvesting technology/ conservation engineering

*Through well-informed decision making, fisheries managers strive to conserve stocks, reduce waste and get more value from the harvest. Managers also try to balance the needs of recreational, commercial and subsistence harvesters. 🌊 Sea Grant scientists and outreach specialists will work with fishermen and managers to invent tools and techniques that reduce unintentional capture of sea life during fishing activities and develop new seafood products from target species to maximize value and yield and reduce waste. Through research and outreach, Sea Grant will also investigate how fishing gear affects habitat and work to help reduce conflicts among different user groups.*

The commercial fishing industry had tremendous potential for growth at the time that Sea Grant was first conceived. Following passage of the original Magnuson Fishery Conservation and Management Act in 1976, our national policy promoted increased harvesting of fisheries resources in order to stimulate the economy and displace the foreign fishing fleet in United States waters. During that period, Sea Grant had significant and successful programs focused on commercializing underutilized species and improving fishing efficiency through new technology.

By the mid-1980s, the situation had changed. Foreign fishing fleets had been displaced and fisheries yield maximized, but many commercial fisheries had either reached or exceeded maximum sustainable yields. Sea Grant interaction with the commercial fishing industry also evolved, and new programs focusing on fisheries



conservation, engineering, value-added processing and new management techniques were implemented. Pioneering efforts by Sea Grant have been responsible for major advances in fishing vessel safety, seafood inspection under Hazard Analysis Critical Control Point (HACCP) guidelines and bycatch issues related to endangered or threatened species. During the same period and continuing today, the number of recreational anglers has dramatically increased with concomitant impacts on fishery resources and their involvement with fishery management issues and political action groups. Conflict has become more complex through the involvement by environmental and conservation advocacy groups in the fishery management issues.

### Research and Outreach Needs

Sea Grant's research and extension roles in fisheries currently face a more dynamic challenge relative to when commercial fisheries were the dominant concern. Commercial fishery problems are now more complex, and the rapid growth in marine recreational fisheries has resulted in increasing conflicts on the fishing grounds and in fisheries management forums. These problems often relate to fishing gear and harvesting strategies, and solutions may be addressed through Sea Grant efforts in the form of research and technology transfer programs.

The issues and controversies associated with tribal fishing rights can be addressed by Sea Grant's strengths in research, outreach and education. The way in which Sea Grant can contribute to tribal rights issues is similar to a role that Sea Grant has previously played in dealing with recreational and commercial fishery user conflicts.

Some specific research and outreach activities that will be developed under this initiative include:

- Developing value-added fisheries products that improve consumer acceptance of current low-value fishes.
- Refining harvesting technologies that maximize landed product quality.
- Developing techniques for species-specific fishing and size selectivity to reduce the amount of bycatch landed.
- Developing methods to evaluate and quantify discard mortality from fishing activities.
- Continuing to find ways in which the fishing industry can avoid interactions with threatened or endangered species, and keep the public informed through outreach activities as to how commercial and recreational fishing can be conducted in a responsible manner.
- Developing alternative baits using fish and animal processing wastes and/or the development of non-animal-based baits.
- Conducting research on the application of area-based management strategies to assist in the conservation and recovery of important fisheries habitats.

### The Role of Sea Grant

Sea Grant's historic non-advocacy role places it in a unique position to work effectively with disparate groups and to provide unbiased, scientifically verifiable information. Considerable effort and capital is necessary to support vital research and extension efforts in order to accomplish this task.



# New approaches to fisheries management



*America's fisheries are under extreme stress from many sources, and new management approaches must be found to cope with the difficult challenges. Sea Grant will participate in cooperative research on subjects critical to decisions by fisheries managers. 🌊 Located in coastal communities and along the shores of the Great Lakes, Sea Grant extension personnel enjoy cooperative working relationships with those interested in recreational, commercial and subsistence fishing. This unique front-line presence allows Sea Grant to facilitate local problem solving and to guide experiments in community-based management.*

The current enthusiasm for partnerships between researchers and commercial fishermen to conduct research may provide an opportunity to explore new approaches to fisheries management. Such cooperative research can include both commercial and recreational fishing groups working in partnership with academic and government scientists. Topics suitable for cooperative research efforts range widely and include stock assessment, fish habitat and behavior, impacts of closed areas, environmental assessment and coastal monitoring. Successful cooperative research efforts will require consensus-building among all stakeholders in setting the research agenda and protocols, use of privately owned vessels and industry organizations to carry out research and data collection and collaborative reporting of results.

Fishermen must be involved in all aspects of the research — from discussion of research needs to presentation of results — if research efforts are to significantly impact fisheries management practices. The entire benefit of fishermen's knowledge and their acceptance of fisheries management practices will be ensured only if they are full partners in cooperative research efforts.

There is an immediate need to understand the mechanisms and processes and to predict the links between changes in marine ecosystems and changes in abundance of commercially exploited marine species. The health of stocks must be assessed based on carrying capacity rather than on historic abundance or demand by fishermen. Recent research results and events have given new urgency to this change in fisheries management paradigms. Oceanographic and fisheries research efforts have demonstrated conclusively that climatic variation significantly impacts commercial fish stocks by altering ecosystem dynamics, including predator and prey abundance, timing and success of recruitment, etc. Recent fisheries management crises have also clearly shown that there are grave difficulties with current single-species management paradigms.

The results of past and present experiments on new approaches to fisheries management by other countries should be integrated into United States efforts toward this same goal. Numerous examples are available including: (1) sentinel fisheries in eastern Canada; (2) individual transferable quota systems for most commercial fisheries in New Zealand; (3) comparative stock assessment studies in Iceland; and (4) the separation of gear types in the Atlantic cod fishery of Norway.

Collaborative approaches to fisheries management are advancing on several levels, with model programs at the state level in Maine, California and Florida. These efforts involve collaborative goal-setting, grassroots watershed actions and cooperative design of management systems. Community-based approaches to fisheries management have the immediate and considerable advantage of including socio-economic impacts in the design and implementation plans for any regulatory measure.



Marine managed areas are being used as fisheries management tools in many coastal regions of the United States. Marine reserves may provide refugia for over-exploited species. They may allow resident species to recover within their borders and enhance productivity outside the reserve. Marine reserves may offer other benefits, including protecting habitat and water quality and enhancing recreational opportunities. Marine reserves should be viewed as one tool among the many useful approaches to fisheries management.

### Research and Outreach Needs

The following research and outreach priorities will be pursued under this initiative:

- Cooperative research on a broad array of topics, including stock assessment, fish habitat and behavior, and coastal ecosystem health.
- Understand and predict marine ecosystem dynamics as they impact the distribution and abundance of recreational species.
- Design and conduct experiments in community-based management.
- Educational and cooperative research efforts aimed at achieving full partnership of the commercial and recreational fishing industries in the stock assessment process.
- Development of experimental areas where new management methods can be tested and studied.
- Conduct a global survey of approaches to fisheries management in order to gain and use new knowledge about what works — and what doesn't — in countries around the world.
- Ensure the broad distribution in the United States academic, government and industry communities of the results of international experiments in new approaches to fisheries management.

## The Role of Sea Grant

Sea Grant should protect its valuable position as a neutral party in the fisheries management arena. As a neutral party, Sea Grant can assist with conflict resolution and facilitate the bringing together of all stakeholders. Sea Grant should strive to maintain excellent working relationships with the commercial fishing industry, recreational fishing groups, NMFS, regional fishery management councils, environmental groups and others. Sea Grant should continue to develop collaborative problem-solving plans and explore strategies for conflict resolution.

It is important to recognize that the communication and coordination of relevant information for fisheries management may be as challenging as acquiring the understanding of how to do it. It is easier to make difficult decisions when people are well informed about what is known and what is not known. Sea Grant, with its established dual capabilities in research and information transfer, is ideally suited to be a catalyst in developing new paradigms for fisheries management. Sea Grant also will be a valued partner in implementing these paradigms by processing research results through its existing network to policy makers, resource managers, fishing industry and other stakeholders.



# Population dynamics

*Some marine and freshwater fishes are commercially harvested while others are protected or not harvested for economic reasons. But all stocks are connected in the ecosystem, and all should be conserved. To make the best decisions, fishery managers must know, within a reasonable degree of certainty, how many fish comprise each population, the rates at which they grow, reproduce and die and the quantity that can be harvested under various scenarios of regulatory measures and fishing pressure.*



The management of both exploited and protected living aquatic resources, whether in marine or freshwater environments, is dependent on estimates of their abundance and dynamics. Such estimates are, by their very nature, imprecise owing to the inability to directly observe and enumerate populations of fish, shellfish, marine mammals and sea turtles. Standardized methods for directly or indirectly sampling these populations and combining such information with harvest estimates from commercial and recreational fisheries have made it possible to estimate relevant population characteristics, although often with considerable uncertainty. The products of these methods, termed stock assessments, provide the scientific input to fisheries management processes employed worldwide.

An assessment includes an estimate of the past and present abundance, size and age structure, and productivity of a stock. In addition, it can contain a quantitative forecast of future stock sizes and harvest levels associated with various management alternatives, such as different exploitation rates, mesh or minimum harvest sizes and closed areas or seasons. Accurate stock assessments and the incorporation of their results into regulatory measures are vital for avoiding

potential drastic reductions in resource abundance and associated economic, social and ecological problems.

## Research and Training Needs

A number of problems have been identified and a series of recommendations for improving stock assessments has been proposed (NRC 1998). Two specific problem areas or deficiencies were identified in an October 1998 NMFS/OAR Science Retreat. Research and training objectives stemming from those recommendations are to:

- Conduct research and development projects to continually produce new and improved stock assessment methods incorporating state-of-the-art technological innovations and statistical theory, including estimates of precision and uncertainty, and to ensure that the very best methods are employed in real-world assessments.
- Collaborate with NMFS scientists in the development of software tools and other analytical approaches for the collection of reliable fishery landings information.
- Field test the sampling bias of survey sampling gears.
- Provide support for graduate training in fish stock assessment.



## The Role of Sea Grant

By teaming with Sea Grant researchers, NMFS scientists can more rapidly resolve the problems associated with stock assessment methods. The problem of attracting qualified people



to fill vacant NMFS positions in stock assessment is also significant. The fundamental problem is that insufficient numbers of quantitative scientists, who also meet the citizenship requirement for employment by the Federal government, are being trained at the MS and Ph.D. levels. Sea Grant universities are in a unique position to play a key role in alleviating this shortage of highly qualified people. A Graduate Fellowship Program in Population Dynamics was initiated in 1999 under the co-sponsorship of the National Sea Grant College Program and NMFS. The program provides funding for up to three years for highly qualified Ph.D. students who are required to work on research topics of interest to NMFS and work summers at a NMFS facility under the mentorship of a NMFS scientist. Present levels of financial support from the co-sponsors permit the awarding of only two fellowships per year and a maximum of six after three years. Further financial support would allow this unique opportunity for training and research to be expanded and would encourage the recruitment of more quantitatively qualified faculty in Sea Grant universities and elsewhere.

# Socio-economics

*Changes in fisheries affect society. It is important that fisheries managers know how their decisions might affect people who depend on fishery resources. When changes affect people, it is equally important to help them cope.  Working cooperatively with government agencies and stakeholders, Sea Grant will provide fisheries managers with the socio-economic data and insight into social and management institutions that are necessary to manage fisheries in a way that minimizes the negative effects their decisions will have on people. Through career training guidance, outreach personnel will help people adjust to changes that profoundly affect their lives.*

The consideration of socio-economic information represents an important step in the development of effective domestic management policy and regulatory measures pertaining to the domestic fisheries of the United States. The mandate to interject the socio-economic dimensions of domestic fisheries into the management process arises primarily through the Magnuson-Stevens Fishery Conservation and Management Act. The Act states that the development of fishery management plans should address the economic and social elements of a fishery. In particular, National Standard 1 defines optimum yield as “maximum yield as modified by economic, social or ecological factors.” National Standard 8 specifies that management measures must minimize the economic impact to fishing communities to the extent practical. In addition, the Regulatory Flexibility Act (PL 104-121) provides the basis by which a determination is made regarding the extent to which small businesses are financially impacted by changes in fishery regulations. The resulting economic and social information represents a critical component of the Regulatory Impact Review and the Initial Regulatory Flexibility Analysis, both of which are required by law to be contained within any fishery management plan developed by the regional fishery management councils.

The domestic fisheries of the United States were historically managed under an open-access management scheme. As the councils developed management plans for the fisheries within



Federal waters, economic data on costs and earnings of typical fishing vessels were gathered. Such information was necessary for determining the level of rent, or profit, existing in the fishery. The optimum level of effort could theoretically be determined that would maximize profit and thereby move managers closer to achieving optimum yield. For some fisheries, such vessel-level economic information is still needed, as effort controls such as trip limits, catch quotas, seasonal closures and gear restrictions continue to be the primary set of management tools. Such management approaches have led to instances of overcapitalization, which in turn have required the collection of additional economic information to describe the extent of overcapitalization. Similar cost and earnings information is also required for more recent and aggressive limited-access management strategies, such as permit moratoria and license limitations, which are specifically designed to mitigate the tendency to overcapitalize.

Rights-based fisheries management represents an alternative approach to fisheries management in the United States. In this case, a fixed level of allowable catch is assigned to an initial number of fishermen, each of whom is assigned an individual quota. Within certain limits, the participants may harvest their individual share whenever and however they choose. The existing market will theoretically provide the overriding direction regarding how and when the individual shares will be harvested. But more importantly, the market will determine who remains in the fishery and who sells out. This management approach requires a new set of economic information to be collected, such that the economically efficient initial allocation of quota among participating user groups can occur. In addition, as new user subgroups are identified, the distribution of quota may need to be adjusted. In addition to cost and earnings data, which are necessary for determining measures of commercial producer surplus, vital information is required to develop a comparable measure of economic surplus for recreational user groups. Equating comparable measures of economic value, or utility, at the marginal unit of production provides the basis from which an initial allocation of allowable catch among user groups can be

prescribed. This initial allocation, and the economic and social information required, is a key step to the success of such a rights-based, limited-access, management program.

## Research Needs

Development of rights-based management schemes may become a more frequently used management tool in the future. Research needs associated with that development include:

- Collection of the economic information needed to measure marginal utilities.
- Development of information on how such management approaches affect fishing communities.
- Definition of a fishing community. A useful definition will be one that accommodates whether the community is urban or rural, commercial or recreational, seasonal or permanent.
- Collections of the economic information necessary to determine how to allocate a total allowable catch properly among multiple user groups.

## The Role of Sea Grant

The role of Sea Grant in ensuring the completion of the appropriate economic analyses is two-fold. First, Sea Grant has the ability to directly conduct some of the necessary economic studies required to address myriad fisheries-related socio-economic issues. This can be accomplished via the Sea Grant marine economics specialist staff. Second, and more important, is the ability of Sea Grant to leverage expertise from other academic institutions and state/federal agencies through applied research funding. Thus, the role of Sea Grant will be one of ensuring that the appropriate applied research teams are developed and funded through the semi-annual call for proposals, as well as via extramural funding at the individual program level. Sea Grant has a strong record of bringing together the appropriate cadre of research and extension expertise to successfully address the wide variety of socio-economic informational needs demanded by fisheries managers.

# Sea Grant Programs

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