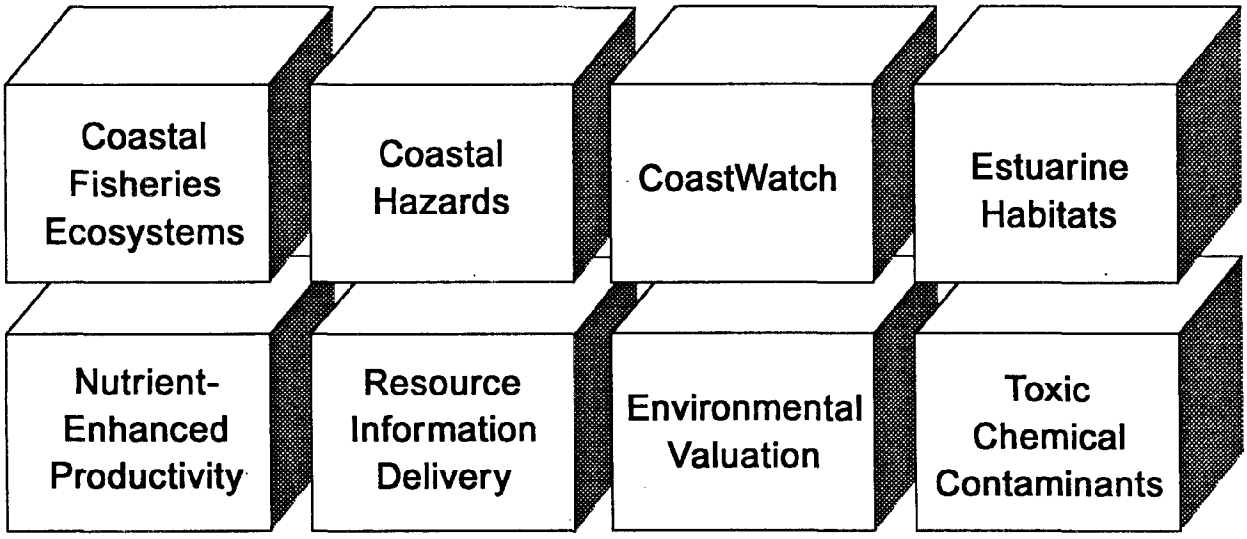
Science for Solutions

NOAA COASTAL OCEAN PROGRAM

Technical Memorandum No. 1

COP FACTSHEETS



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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Coastal Ocean Office

NOAA COASTAL OCEAN PROGRAM
TECHNICAL MEMORANDUM SERIES

This series presents pertinent research, data, and information materials that have been developed within the Coastal Ocean Program (COP).

No. 1, "COP Factsheets," has been developed as a quick guide to current projects.

To learn more about the program or about the projects listed, please write:

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June 1994

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U.S. DEPARTMENT OF COMMERCE
Ronald H. Brown, Secretary
National Oceanic and Atmospheric Administration
D. James Baker, Under Secretary
Coastal Ocean Office
Donald Scavia, Director

NOTE TO READERS

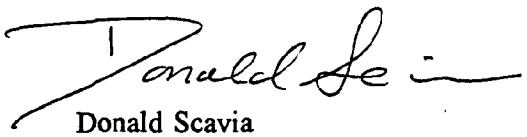
The NOAA Coastal Ocean Program (COP) provides a focal point through which the agency, together with other organizations with responsibilities for the coastal environment and its resources, can make significant strides toward finding solutions to critical environmental problems. By working together toward these solutions, we can ensure the sustainability of coastal resources and allow for compatible economic development that will enhance the well-being of the Nation now and in future generations.

The goals of the COP parallel those of the NOAA Strategic Plan for 1995-2005. These goals center around Coastal Ecosystem Health, Fisheries Productivity, and Coastal Hazards Prediction. The vision of the program is to provide the highest quality scientific information in time for critical coastal decision making. The aim of the COP is to provide information that is predictive, and this predictive information builds upon research on impacts and natural variability, monitoring, and assessment. Toward this end, the COP supports a broad suite of projects ranging from scientific investigation to information delivery. Funding has generally been provided on about an equal basis to NOAA principal investigators and to academic researchers.

Since its formation in 1990, the COP has pursued a proactive and innovative approach to studying the coastal ocean. Additionally, it has provided a leadership role in focusing NOAA science on high-priority topics and on developing the coordination of federal coastal ocean science.

The COP has many successes which we do not review here. *COP FACTSHEETS* is designed to acquaint readers with what projects the COP is funding today and in the near-term on the Nation's pressing coastal issues and to portray how the office is providing leadership in addressing these vital concerns. Projects are presented topically in relation to COP activities and goal areas. Each project is numbered in order of this topical presentation and appears under its appropriate grouping in the Table of Contents. To facilitate specific usage of the *COP FACTSHEETS*, the Index organizes projects by project title, by program area, by state, by region, by COP theme, and by project application to specific scientific topics of interest.

We welcome your interest in the work we are doing. Therefore, we encourage you to write, fax, call, or Internet us with your comments or questions about our current activities presented here. Please be assured that we will appreciate these comments, either positive or negative, and that they will help us direct our future efforts. Our address and telephone and fax numbers are on the inside front cover. My Internet address is DSCAVIA@HQ.NOAA.GOV.



Donald Scavia
Director
NOAA Coastal Ocean Program

NOAA COASTAL OCEAN PROGRAM
FACTSHEETS
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NOAA COASTAL OCEAN PROGRAM

New Directions in Coastal Ocean Science and Policy

SETTING A COURSE FOR U.S. COASTAL OCEAN SCIENCE: SUBCOMMITTEE ON U. S. COASTAL OCEAN SCIENCE (SUSCOS)

THE ISSUE:

The coastal ocean, comprised of the ocean from the shore to the continental shelf break, estuaries, embayments, and the Great Lakes, is of immense economic and environmental importance to the Nation. This diverse environment includes resources that represent the world's most biologically productive ecosystems, reserves of strategic minerals and other nonliving resources, and unparalleled opportunities for recreation and tourism. Over the next 50 years, almost half of the national population growth and development will take place immediately adjacent to the coastal ocean, producing enormous pressures on our coastal resources. In order to address the complex coastal issues that arise when economic development and environmental health must be balanced, new management approaches are required.

THE APPROACH:

In 1991, the Federal Coordination Council on Science, Engineering, and Technology (FCCSET) established a Subcommittee on U. S. Coastal Ocean Science (SUSCOS) under the Committee on Earth and Environmental Sciences (CEES) to: (1) improve planning, coordination, and communication among Federal agencies involved in coastal ocean science, and (2) systematically improve the scientific basis for environmental management and policy decisions. Wise stewardship of the coastal ocean will ultimately require a policy of integrated management, which will demand support from a new approach to scientific research in the coastal ocean. SUSCOS evaluated the strengths and weaknesses of current U. S. coastal ocean science and has set the stage to pursue new approaches to science in support of improved management and stewardship of our coastal and marine resources.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

In Phase 1 of its work, SUSCOS completed an inventory of Federal programs supporting coastal ocean science. The SUSCOS inventory reports that total direct Federal research investment in the coastal ocean was $228 million in FY91, $218 million in FY 1992, and $226 million in FY 1993. Contributing research (referring to U. S. research sponsored in non-U. S. waters or activities which provide supporting measurements, observations, or services crucial to the coastal ocean science framework) was $116 million, $98 million, and $119 million for the respective three years. The inventory also highlighted more than 40 significant research gaps in the coastal ocean science agenda that have been identified over the past five years by panels of the National Academy of Sciences and workshops of academics and Federal agency personnel. SUSCOS has also completed Phase 2 of its task in developing a national strategy for coastal ocean science, which is directed at integrating ongoing efforts and promoting the synergy required to tackle multidisciplinary problems that arise from complex societal issues. Publication of both Phase 1 and 2 are expected in 1994.

A NATIONAL AGENDA FOR COASTAL OCEAN SCIENCE: NATIONAL SCIENCE AND TECHNOLOGY COUNCIL SUBCOMMITTEE (NSTC)

THE ISSUE:

The cumulative effects of accelerated development, human activities, and natural hydrologic and climatic patterns have resulted in degradation of many of the Nation's water resources and aquatic environments which has had a significant economic and social impact. While development offers benefits to society, the attendant needs for increased disposal of wastes, and consumption of energy, water, and food resources compel communities to manage that change more effectively. Managing for change includes balancing prevention, mitigation, and adaptation. To manage for change most effectively, one needs to observe, understand, and then anticipate. The role that science can play is to develop a scientific understanding of aquatic processes so that change may be predicted and management options evaluated.

THE APPROACH:

President Clinton established the National Science and Technology Council (NSTC) and a series of committees to oversee all Federal R&D. The Committee on Environment and Natural Resources Research (CENR) was established under the NSTC to increase the overall effectiveness and productivity of Federal environment and natural resources R&D. The Water Resources and Coastal and Marine Environments Research Subcommittee (Water Subcommittee) of the CENR on which COP sits was established to: (1) assess the quality and integrity of the Nation's aquatic environments, (2) assess the adequacy and management of the Nation's freshwater resources to meet present and future needs, (3) predict the impacts of natural and anthropogenic changes on aquatic environments, and (4) assess the international water and aquatic environment resources of national and international economic and security interests.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

In April of 1994, an external science review was held at the National Academy of Sciences for the research and development plans created by CENR subcommittees. Based on the comments from this review process, FY94 research priorities were identified for each of CENR's subcommittees, thus creating a National Environmental R&D Strategy. The goal of the Water Subcommittee, like the former Subcommittee on U.S. Coastal Ocean Science (SUSCOS), is to ensure reliable supplies of clean water as an economic resource and to ensure the integrity of aquatic ecological systems. The focus of the Water Subcommittee in this national environmental strategy is to center research around these national environmental goals and to target geographic locations for multidisciplinary research. This research is targeted to develop a stronger scientific base for management decisions. Specific areas of study include: the development of an interagency terrestrial and coastal observing and monitoring system; the investigation of mass balance studies which look at the flux and fate of water and dissolved and particulate material from the atmosphere through the watershed and into estuaries and the coastal ocean; and the development of an interdisciplinary (physical, biological, and social) science program to guide the management and restoration of aquatic ecosystems.

NOAA CENTER FOR COASTAL ECOSYSTEM HEALTH

THE ISSUE:

Since 1960 the coastal population has increased by 32 million and if the trend continues, will increase by another 15 million in the next 20 years. This population growth generally has a positive impact on a region's economy by creating new local jobs and opportunities. A variety of environmental quality problems, like waste disposal, nutrient overenrichment, and habitat loss, and resource depletion problems, like declining fisheries, are also partially attributed to coastal population growth. To minimize, control, or mitigate these problems, Federal, State, and local resource managers need science-based information, data, and innovative strategies for establishing integrated policies and regulations to support sustainable development.

THE APPROACH:

The NOAA Center for Coastal Ecosystem Health is being established in Charleston, South Carolina. Congress appropriated new funding in 1994 to support development of improved coastal ecosystem monitoring, assessment, and management capabilities for the nation. NOAA has taken this opportunity to address the Nation's coastal environmental problems and to demonstrate innovative partnerships with Federal, State, local, and private institutions. The new Center will serve as a focal point for addressing coastal environmental quality problems in the nation such as nonpoint source pollution, nutrient overenrichment, and habitat loss and degradation. COP chairs the Management Committee for the Center

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

The goal of the Center is to contribute to improved management strategies for achieving coastal biological, cultural, and economic sustainability. This will be achieved by bridging the gap between science and management to provide the technologies, methodologies, and information necessary to assess, predict, and improve the health of the nation's regional coastal ecosystems and their living marine resources. It emphasizes NOAA commitment to achieving sustainable economic development while maintaining a healthy coastal environment.

NOAA has established a policy level management committee of senior NOAA managers to oversee the Center's program and operations while also including State managers in the development process. Teams of NOAA and regional experts are developing work plans for initial Center efforts. These plans will define the preliminary facility, staffing, and other resource requirements associated with the Center's start up. Initial activities will include: monitoring activity (an interdisciplinary monitoring and prediction element, instrument technology development, and a remote sensing capability); restoration services (rehabilitation of impacted coastal habitats and improved management of coastal resources); and data and information management (a data and information system element, a management information and synthesis element, and a data publishing and clearinghouse element). Center staffing will include employees in fields ranging from science and engineering to data and information management. Start up activities in Charleston have gotten underway in the late summer of 1994.

FLORIDA BAY RESEARCH PROGRAM

THE ISSUE:

Seagrasses in western Florida Bay have been dying since the summer of 1987. The Bay is important as a principal nursery for the Tortugas pink shrimp fishery and many important finfish species. The Bay also supports populations of the bottlenose porpoise and other noteworthy species. Changes in resident fishery populations associated with the Bay's habitat changes are occurring, while atypical phytoplankton blooms with attendant loggerhead sponge dieoffs have been reported across much of the western Bay. While the causes of these problems and the relationships among them are not well understood, there is no question that the Florida Bay coastal marine ecosystem is in jeopardy.

APPROACH:

In response to heightened local concerns about the deteriorating conditions in Florida Bay, a Federal-State agreement was signed establishing an interagency Task Force which then called for development of a Florida Bay Science Plan. The Coastal Ocean Program participated in the NOAA team to develop a research implementation plan with respect to the agency's interests and responsibilities in the Bay. FY94 COP activities proposed in the Florida Bay research implementation plan will focus on the larger oceanographic, atmospheric, and fisheries context within which Bay restoration will proceed, including linkages with the adjacent Atlantic and Gulf of Mexico ecosystems. Florida Bay represents a new program for COP and is expected to continue past FY94.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

The activities detailed in the NOAA implementation plan are organized into the categories of retrospective analyses, monitoring, modeling, and acquisition of critical new information through both field studies and laboratory experiments. COP is funding several of the Florida Bay projects that will be undertaken including an evaluation of seagrass habitat health and diversity, interpretation and groundtruthing of aerial photography of bottom habitat, and a pesticide analysis in Florida and their contribution to the waters in Florida Bay. Most of the proposed NOAA FY 1994 activities are designed to characterize and model the system and to build upon and be integrated with efforts already underway in NOAA and other agencies. Products from continued NOAA effort will include development of a remotely sensed (airborne and satellite) data archive of relevant Florida Bay data, development and adaptation of mesoscale and ocean circulation models, and technical publications to disseminate data and information on many Florida Bay parameters such as seagrass, zooplankton and macrobenthos abundance; biodiversity, fishery, and marine mammal estimates; pollutant loadings; and ecosystem relationships.

CUMULATIVE EFFECTS OF MULTIPLE STRESSORS

THE ISSUE:

The coastal region of the U.S. is rapidly changing. Since 1960, the coastal population has increased by 32 million and if the trend continues, will increase by another 15 million in the next 20 years. The combined impacts of the anthropogenic pressures caused by this population shifts -- the impacts of habitat modification, nutrient and toxic inputs, and fresh water diversions -- are poorly understood. Traditional management responses to anthropogenically induced coastal degradation have been focused on individual potential causative factors (e.g., toxic, nutrients, habitat loss) rather than on the interactions of natural and anthropogenic stressors in nature. Better understanding of the cumulative effects and development of integrative approaches to manage these effects is needed for the wise use and protection of coastal resources.

THE APPROACH:

The COP is supporting an integrated multi-investigator, multi-disciplinary program of process studies, monitoring, modeling, assessment, and environmental valuation with the overall goal to predict impacts of multiple stressors on coastal resources, particularly in the context of integrated resource management assessment. Subgoals are to:

- o quantify the magnitude and effects of specific natural and anthropogenic stressors and for combinations of those stressors;
- o identify integrated indicators of stress at individual, population, and ecosystem levels; and
- o evaluate effectiveness of potential alternative mitigation approaches by combining where possible the linkages between biological and human service functions of ecosystems.

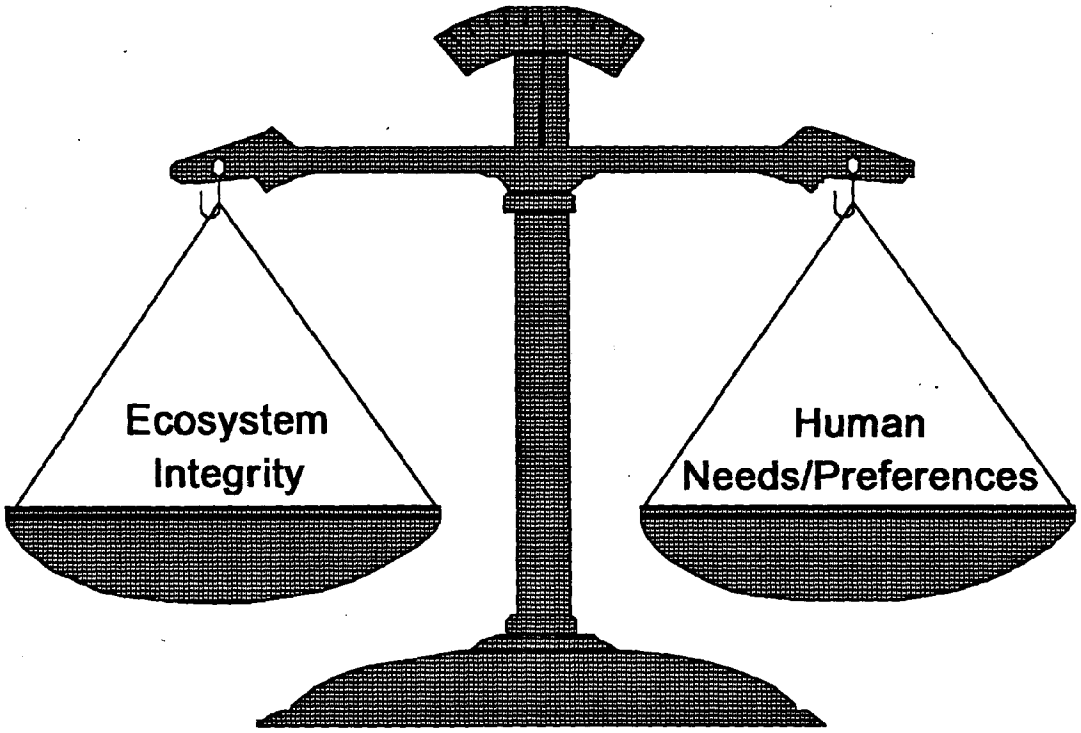
Over the course of these multi-year efforts, NOAA intends to strengthen its internal capability to work at an integrated, ecosystem level together with external partners.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

An announcement of availability of funds to initiate one or more site-specific program was distributed by COP in FY94. Evaluation of proposals will be based on the conceptual model of the relationships among major components of the area's ecosystem, the design of the scientific program, and its application to management. COP anticipates funding at least one site-specific program for up to five years and additional site-specific programs if funding is available. Selection of FY94 proposals is expected by mid September 1994.

NOAA COASTAL OCEAN PROGRAM

Environmental Valuation



ENVIRONMENTAL VALUATION WORKSHOPS

THE ISSUE:

The diverse needs and wants of a large and rapidly growing coastal population are now severely limited in many parts of the U.S. by the fixed supply of coastal resources and the limited capacity of natural ecosystems to assimilate human impacts. Exacerbating this problem is our inability to properly assign values to coastal environmental resources that can be compared with the value of these resources when traded in the market. The important costs and benefits of environmental resources must be taken into account for wise stewardship and management decisions.

THE APPROACH:

The COP is providing comprehensive information on the methods, assumptions, limitations, and applications of natural resource economic valuation to State and local planners, coastal zone and marine sanctuary managers, and natural resource trustees. The COP is supporting the development of the curriculum and workbook for a series of regional workshops in order to deliver to these planners and resource managers the training in environmental valuation methods and applications that will provide them with tools for use in policy and decision making.

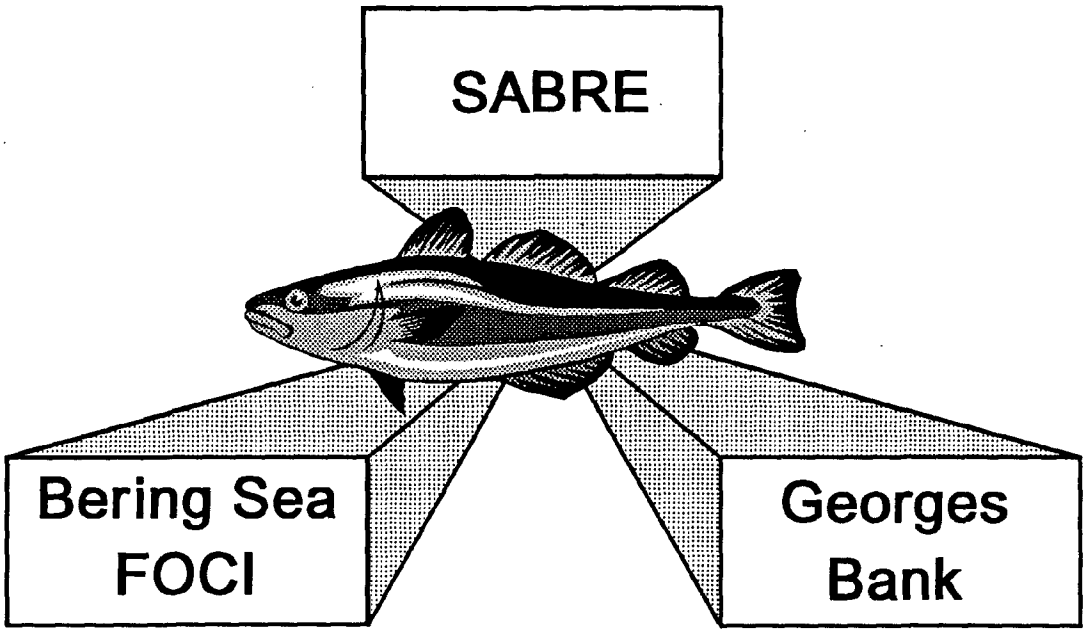
ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

After holding two pilot workshops in 1992 and 1993, a two-day Northwest Pacific Environmental Valuation Seminar with an improved curriculum and workbook was held in February 1994. Response to this seminar was so enthusiastic that it was followed by a joint NOAA-EPA seminar in Seattle, WA in the summer of 1994 A seminar in Portland, OR is scheduled for fall 1994. Additionally, a joint NOAA-EPA seminar was held in Boston in May 1994. As an offshoot of these seminars, a two-day discussion of valuation techniques led by experts in the field was held in Casco Bay, ME in June 1994. Workshops in Columbia, SC; Chesapeake Bay, MD; and the Great Lakes are also being planned for the end of 1994 and early 1995.

NOAA COASTAL OCEAN PROGRAM

Coastal Fisheries Ecosystems

Major Projects



COASTAL FISHERIES ECOSYSTEMS (CFE)

THE ISSUE:

Since 1991, the National Marine Fisheries Service annually reviews the status of more than 230 groups of finfish, shellfish, corals, marine mammals, and sea turtles representing more than 450 species. In the report issued for 1993, for those species having sufficient scientific information to determine their status, 28% were judged to be overutilized while 31% were fully utilized. There was insufficient information to make an informed judgment for another 29% of these U.S. living marine resources. The overutilized resources include some of the Nation's most valuable fisheries. To increase long-term potential yields of these fisheries with economic benefit to the Nation, stocks must be rebuilt. In addition, many other productive fishery resources are also threatened by the lack of information for stock size and condition and natural variability in the ocean environment.

THE APPROACH:

The overall goal of the Coastal Fisheries Ecosystems theme is to reduce uncertainty in resource management decisions through ecological research to improve the conservation and management of living marine resources. Study in three areas are being pursued to help reduce this uncertainty: 1) recruitment variability; 2) compensatory mechanisms; and 3) species interactions. Each effort addresses the need to understand the links between environmental variability and the biophysical processes controlling populations. Because these questions are difficult, a long-term research strategy and funding commitment is necessary with individual projects conducting research in parallel according to these three objectives on important species in different ecosystems.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Two CFE projects were initiated in FY 1991 in the South Atlantic Bight and in the Bering Sea, and one other was funded in 1993 in Georges Bank. Initial products from the program include the development of cost-effective techniques for assessing stock size and distribution; improvement of indices of fish abundance and forecasts of fishery recruitment; identification of the physical, chemical, and biological factors controlling population abundance; advancement of multispecies/yield models to help evaluate alternative management scenarios; development of a means for distinguishing between natural variability and changes in population size produced by human actions and/or activities; development of scientific information that relates effects of anthropogenic stressors, including fishing, in "common currency" amenable for management decision input; and the enhancement of scientific exchange and publication output resulting in more credible scientific tools. It is anticipated that several additional projects can begin in outyears, thus allowing CFE to augment research over a more diverse array of ecosystems, taxonomic groups, and life history strategies and to improve the long-term body of knowledge available to decision makers.

COASTAL FISHERIES ECOSYSTEMS
SOUTH ATLANTIC BIGHT RECRUITMENT EXPERIMENT (SABRE)

THE ISSUE:

Atlantic menhaden is the most economically important fishery in the South Atlantic Bight. It is also the primary forage base for many game fishes in the region and critical to the community ecology of the South Atlantic Bight. Yet there is inadequate information on the impact of environmental factors on its maturation. Moreover, the estuarine dependent life history pattern of menhaden is typical of many commercially important fish along the East and Gulf coasts, and this species may serve as a model for understanding similar species.

THE APPROACH:

Critical phases in the life history of Atlantic menhaden -- offshore spawning, onshore transport, estuarine development, and offshore transport and migration -- are being examined to determine when and where bottlenecks occur that limit recruitment. The project aims to improve the management of menhaden and similar commercial species through a better understanding of the ecological processes regulating population size. SABRE is a coordinated field and modeling effort including NOAA laboratories, academics, and State resource agencies.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

In FY91, a meeting supported by the Cooperative Institute of Fisheries Oceanography (CIFO) was held in February at North Carolina State University to discuss research issues and priorities for the South Atlantic Bight, and to develop a project work plan. Eleven projects were selected for funding, and field sampling was initiated. Groundwork completed in 1991-93 include: a synthesis of available physical and biological background databases for the area; initiation of theoretical/modeling efforts focusing on physical dynamics and biological parameters; the design of protocols for field egg sampling and laboratory otolith (ear structure) analyses; field sampling to determine horizontal and vertical distribution of larvae; laboratory experiments to age fish through otolith analysis; synthesis of Atlantic menhaden population data and stage-within-age-based model; and development of field verifiable tests of the an optical video integrated "smart-sampler."

Plans for FY94 focus on initiating an integrated field/lab/model program to identify loci of recruitment variability in Atlantic menhaden along the North Carolina coast. Included in this task are: physical measurements to relate coastal current and inlet mouth dynamics; offshore biological sampling studies of egg and larvae; inlet sampling of larvae; further improvements in otolith analyses; and development of models inlet passage and physical circulation with the individual cohort models.

COASTAL FISHERIES ECOSYSTEMS
BERING SEA FISHERIES OCEANOGRAPHY COORDINATED INVESTIGATIONS (FOCI)

THE ISSUE:

Bering Sea pollock provide the world's largest single-species fishery. Approximately half of the catch occurs within the U.S. Exclusive Economic Zone. The remainder comes from both the western Bering Sea (Russian territory) and, at times, from an international fishery in the "doughnut hole" that lies outside the EEZ's of all nations. It is believes that two coastal stocks (eastern and western) provide the majority of fish. Present knowledge indicates the majority of animals result from spawning in the southeastern Bering Sea shelf. To what extent these stocks intermingle and provide the spatially complex fishery is not known. Furthermore, the natural factors which cause large interannual variations in year-class strength need elucidation to develop reliable estimates of recruitment. FOCI research provides information to resource agencies such as the International Convention on Conservation and Management of Pollock Resources and the U.S. North Pacific Fishery Management on the nature of stock structure, the contribution of spawning over the slope to shelf populations, and on survival of animals (eggs through young-of-the-year) in the three distinct habitats of the eastern shelf.

THE APPROACH:

FOCI addresses questions of stock structure throughout the Bering Sea and on survival of early life history stages in the eastern Bering Sea. Studies focus on genetics, transport phenomena both over the basin and slope and onto the eastern shelf, and biophysical processes in the three distinct domains extant on the shelf that impact survival of young animals. Ultimately, the project aims to provide information which will reduce the uncertainty of management decisions for the critical fishery through an improved knowledge of the ecological processes affecting population distribution and size. This will be accomplished by developing indices of various biophysical processes which occur during the early life history.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

In February 1991, NOAA co-sponsored an international workshop to assemble relevant data on the Bering Sea fishery and to develop a cooperative research plan. In August 1991, FOCI funded the first of several U.S. research cruises into the Soviet portion of the Bering Sea. In FY92, eight of the ten projects received continued funding, and one new project was funded in pollock larval growth, transport and mortality. In FY93, field monitoring and observations were used to develop a comprehensive view of upper ocean circulation. An improved meteorological, physical, and biological oceanographic mooring helped to understand how springtime eddies coincide with larval pollock. Sampling and modeling have helped to characterize and understand larval feeding and growth conditions. FY94 emphasized expanding and refining knowledge of processes affecting the survival of eggs, larvae, and juvenile pollock and comparing these processes on the slope and shelf. FY95 will look to complete research on genetics, larval feeding, and ocean transport, and focusing on egg to young-of-the-year life stages and processes affecting them in the three shelf domains. Spring and summer field work will involve U.S. and Japanese ships and a NOAA research aircraft to make synoptic measurements of low-level winds and ocean color.

COASTAL FISHERIES ECOSYSTEMS
PREDATION AND STRUCTURE OF THE GEORGES BANK ECOSYSTEM

THE ISSUE:

Georges Bank, off the U.S. northeast coast, is one of the most biologically productive areas in the temperate coastal ocean. This ecosystem has undergone profound changes due to intensive exploitation during the last three decades. The arrival of distant water fleets on Georges Bank in the 1960s resulted in massive ecological shifts, resulting in significant changes in community dynamics. At the height of the fishery (1973), nearly one million metric tons of biomass were removed from the system. Valuable species, such as Atlantic cod and haddock, have been depleted to near economic extinction and replaced by low-valued species of dogfish and skates which are important predators of commercially valuable species. During this period, the percentage of the region's total catch of cod and haddock has dropped from 70% to 15% as a result of overfishing.

THE APPROACH:

A COP-sponsored research project is examining the ecosystem characteristics which affect efforts to restore cod and haddock populations, including the feeding behavior of predators and the availability and distribution of food for young fish. The research addressing the above issues using a combination of: 1) retrospective studies of changes in biomass relative species composition and feeding interactions using multivariate time series of change, description of trophic structure of Georges Bank system, studies on specific compensatory processes for definition of stock recruitment, and preliminary consumption estimates for multi-species models; 2) field and laboratory observations and experimentation designed to increase the precision of consumption rate estimates and to test competing hypotheses; and 3) development of multispecies models of Georges Bank for evaluating production potential of cod and haddock under alternative fishing strategies and fish community configurations representing different levels of predation stress. The goal is to provide advice to fishery managers on harvesting strategies for the multispecies fish community as a whole.

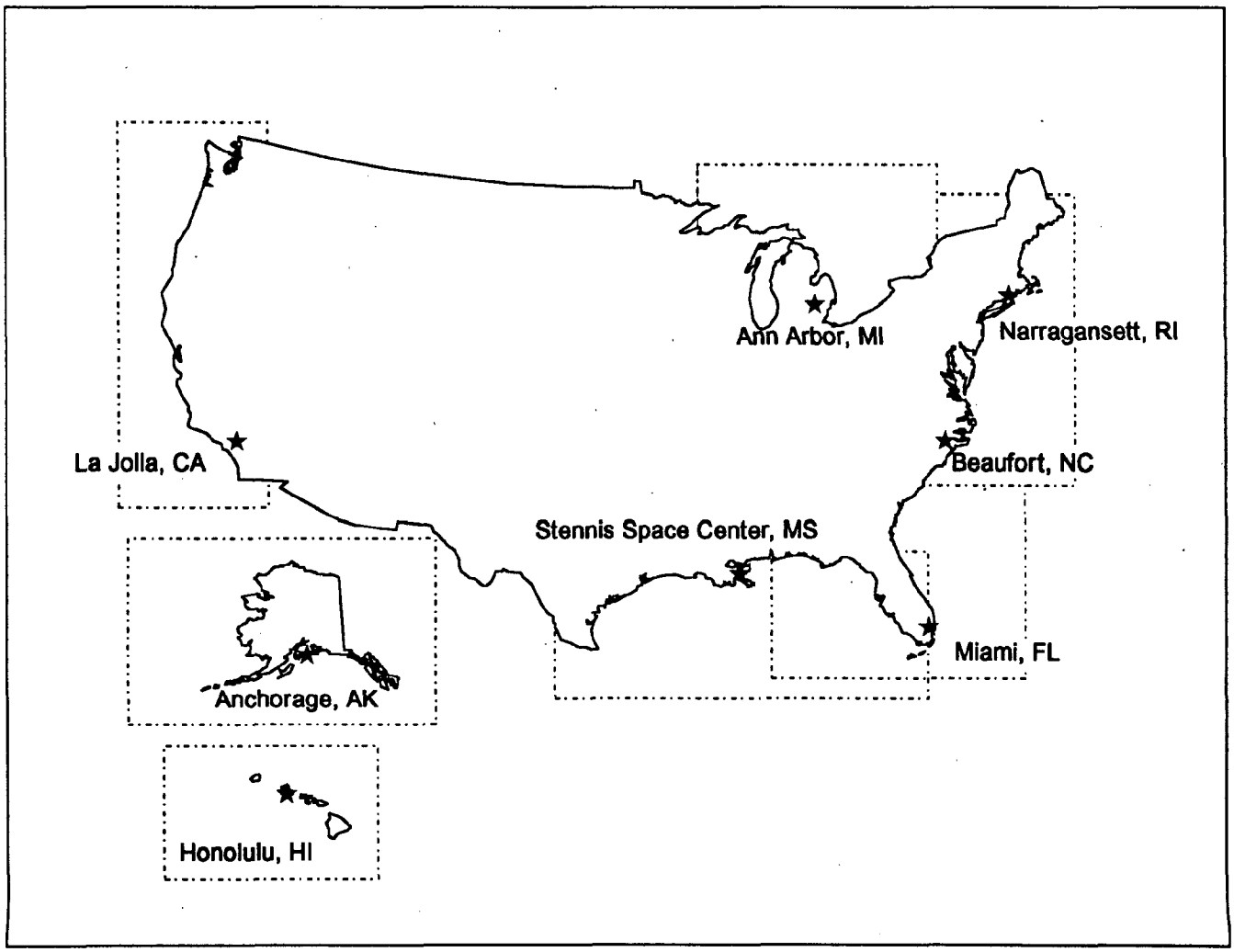
ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

The project was initiated in FY93. Lab studies are being initiated in FY94 to develop biochemical probes of identifying digested remains of larval cod in fish stomachs. Stomachs of major fish species will continue to be sampled during the fall, winter, and spring trawl surveys and special cruises to study predation. Development of multi-species models will continue with the following activities: evaluation of temporal/spatial characteristics of available databases on food habits and density distribution overlap of predators and prey; determination of possible structure and feasibility of parameterizing candidate multi-species models; evaluation of available modeling software packages to facilitate model development; exploration of properties of candidate models; sensitivity analysis to indicate critical parameters; and examination of key questions such as relative importance of predation on pre-recruits vs. post-recruits, and implications of density-dependence and non-linear functional feeding responses.

NOAA COASTAL OCEAN PROGRAM

CoastWatch

Regional Nodes



NOAA COASTWATCH

THE ISSUE:

In the fall of 1987, a "red tide" event, a toxic plankton bloom, occurred off the North Carolina coast, causing an estimated $25 million loss to fisheries and tourism for that area when State authorities had to close shellfish beds for several months. NOAA's polar orbiting satellites were able to detect ocean thermal features associated with the event in the data collected from the Advanced Very High Resolution Radiometer (AVHRR). These were then translated into high resolution sea surface temperature (SST) images which provide the means for tracking this toxic marine algae as well as for many other activities and phenomena that are associated with sea surface temperatures.

THE APPROACH:

CoastWatch is designed to provide satellite remotely sensed and in situ environmental data and information to Federal and State decision makers and researchers in a timely and accessible manner. CoastWatch focuses on regional and national priorities, such as unusual environmental events and tracking algal biomass that contribute to toxic phytoplankton blooms. It is a cooperative effort involving the COP and all NOAA Line Offices including the National Weather Service (NWS), National Ocean Service (NOS), National Environmental Satellite, Data and Information Service (NESDIS), Oceanic and Atmospheric Research (OAR), and National Marine Fisheries Service (NMFS).

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

The CoastWatch program has made significant progress in its initial objectives: 1) to provide access to near real-time and retrospective satellite and in situ data and aircraft observations to decision makers and researchers; 2) to enhance communications systems supporting access to and distribution of near real-time and historical satellite and in-situ observations of coastal ocean users; and 3) to enhance workstations and associated software for integrated analyses of environmental quality, fisheries oceanography, and coastal hazards. Regional sites have been established to collect, process, calibrate, validate, archive, and distribute the data. Focus for the program now is to develop and apply products. Such applications include the Red Tide Watch, Turtle Excluder Devices Project, El Nino Watch, Zebra Mussel Predictions, and the Synthetic Aperture Radar Project.

NOAA COASTWATCH
TURTLE EXCLUDER DEVICES (TEDs)

THE ISSUE:

Endangered sea turtles have been shown to exhibit a preference for warmer waters, and these turtles are often accidentally captured by trawlers fishing in these productive waters. If trapped in a trawl for an extended period of time, these turtles can drown. Information on sea surface temperature (SST), which is available from space-borne platforms, would enable fisheries managers to exercise adaptive management practices by requiring trawling operations with TEDs in areas of warmer water and allowing trawling without TEDs in areas of cooler water, thus reducing the likelihood of capturing, and possibly drowning, the endangered turtles.

THE APPROACH:

CoastWatch imagery, supplied by the Coastal Ocean Program, has been used extensively to understand the role of temperature in mediating the distribution and migration of sea turtles in the coastal ocean, and in a cooperative plan between NMFS and the State of North Carolina, to monitor and protect them. NMFS uses a combination of available turtle observations and CoastWatch SST imagery to estimate the relative risk of trawling to turtles and adjusts the geographic requirements for TEDs. The application of research, satellite imagery, and other data to this problem facilitates an adaptive management approach to the regulation of the trawling activities and protection of sea turtles.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES

In December 1990, these data were instrumental in the decision by the State of North Carolina to suspend the fish trawling season in the Hatteras Bight. In 1991, SST imagery played a vital role in continued management of this fishery and in research to better our understanding of the factors affecting sea turtle distributions. Imagery from the winter of 1992-1993, coupled with 1991 aerial observations on the temporal and spatial distribution of sea turtles, indicated that temperature conditions north of Oregon Inlet, NC, were similar to those observed in December 1991. Based on those observations, NMFS expected that nearshore water temperatures north of Oregon Inlet would decline and that this decline would reduce the probability of sea turtle capture by summer flounder trawlers. This led NMFS to reduce the area where the use of TEDs was required by lifting the TED use requirement in the area north of Oregon Inlet to Cape Charles, VA.

NOAA COASTWATCH
RED TIDE WATCH

THE ISSUE:

Paralytic shellfish poisoning (PSP) is a major public health risk in certain areas along the coast. It is caused by "red tides" or "blooms" of microscopic marine organisms, which develop under certain natural environmental conditions. The organisms that cause PSP are not harmful to the filter-feeding shellfish that concentrate the toxin, but it is highly toxic to humans. The "blooms" force State authorities to close shellfish beds for several months, thereby causing economic disaster for commercial fishermen. Satellite-derived sea surface temperature (SST) images provide the means for tracking this toxic marine algae.

THE APPROACH:

The goal of the CoastWatch Red Tide program is to achieve effective management of fisheries, public health, and ecosystem problems related to marine biotoxins and harmful algae to protect the public from tainted shellfish through monitoring programs and harvest restrictions. The development of forecasting capabilities for the occurrence and impacts of harmful marine algal blooms is needed. Investigations into the environmental conditions associated with toxic bloom episodes indicate that some "bloom" organisms are associated with identifiable water masses, and oceanographic features such as fronts, or advected by coastally trapped river plumes. CoastWatch regional nodes distribute SST images and other environmental data to researchers and Federal and State resource managers to facilitate the identification of potential harmful bloom conditions.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

On the West coast, red tide efforts are concentrating on the feasibility of modeling the development of red tides, with the goal of being able to predict potential areas and times that "blooms" may occur, based on critical environmental information. This was the subject of a Harmful Algal Bloom Workshop held August 17-19, 1993, at the NOAA CoastWatch Regional Node, La Jolla, Ca. Satellite images have been distributed to State public health officials who conduct monitoring programs for the occurrence in shellfish of PSP.

In the Southeast, research efforts have focused on identifying the causes of a severe red tide off the North Carolina coast and on monitoring for new outbreaks. In the Chesapeake Bay, a cooperative program between NOAA and the Chesapeake Bay Program has focused on improving the quality of information about spring algal blooms in the Bay. Researchers at Woods Hole Oceanographic Institute have shown CoastWatch SST imagery to be a useful tool in studies of "red tide" blooms and the onset of PSP in the southeastern Gulf of Maine. On a national scale, remotely sensed SST has great promise as a tool to provide early warning of the conditions conducive to bloom development. A reliable forecasting capability will allow managers to concentrate monitoring efforts in identifiable, high risk areas and reduce the need for geographically broad harvesting restrictions.

NOAA COASTWATCH
EL NINO WATCH

THE ISSUE:

Along the west coast of North America, there are major alterations in ocean conditions associated with El Nino events which can cause drastic ecological and economic consequences -- e.g., the impacts on West Coast living marine resources may be disastrous or beneficial. West Coast Federal, State, and local agency managers and scientists require timely information concerning El Nino conditions for making decisions related to fisheries management, coastal zone management, water quality, and research.

THE APPROACH:

With Coastal Ocean Program support, the El Nino Watch was started in January of 1992, in response to the onset of El Nino conditions in the Equatorial Pacific. One manifestation of El Nino events is the persistence of anomalously warm surface water off the West Coast. Monthly El Nino Watch Advisory Charts are issued by the West Coast Regional Node, covering the coastal ocean conditions for the continental West Coast. These advisory charts summarize the sea surface temperature anomalies based on in situ data from the National Weather Service, describe the oceanographic conditions, and the potential impacts on living marine resources.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

The West Coast Regional Node prepares and issues El Nino watch advisories which include analyses of coastal ocean mean sea surface temperature (SST), deviations of SST from normal, information on ocean currents, thermocline structure, and other conditions as available. During 1993, twelve El Nino Watch Advisories were issued to over 300 primary users who frequently distribute or post the information for further access by others. As of Spring 1992, approximately 125 users received these advisories. This number is expected to increase. Satellite images showing ocean temperature distribution are distributed electronically to a smaller number of users who require more detailed information. In addition to these advisory charts, the El Nino Watch functions as an information clearing-house, makes data available from cruises conducted to evaluate impacts of El Nino conditions on selected fish stocks, and gives presentations to the public.

NOAA COASTWATCH
ZEBRA MUSSEL PREDICTIONS

THE ISSUE:

The introduction of non-native species to eastern North America is a continuing concern to industries, coastal communities, and State and Federal resource managers. Since the 1800's over 136 different species have been introduced into the Great Lakes basin, including the zebra mussel (*Dressena polymorpha*). Problems arise from zebra mussel colonization when they adhere to water intake pipes, thus reducing the flow through these pipes, and when they adhere to other structures in the water such as boats and docks. Problems also arise when the dead, sharp shells litter the shoreline and when the mussels are transported from one location to other inland rivers and lakes. As knowledge spread of the devastating impacts occurring at Detroit Edison and Monroe Michigan water utility in the fall of 1989, managers wanted to know what areas were likely to be impacted by zebra mussel colonization.

THE APPROACH:

Using Green Bay, Lake Michigan, as a test site, researchers evaluated the physical parameters, water temperature during the spawning season, water depth, and available substrate to identify areas of probable colonization. These were then compared with other factors such as calcium availability and pH levels to develop a working model to estimate where zebra mussels are likely to occur in inland water bodies.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Surface water temperature data were obtained from the CoastWatch Advanced Very High Resolution Radar (AVHRR) images through the NOAA CoastWatch program. These data were received from the Coastal Ocean Program sponsored CoastWatch Regional Node at the Great Lakes Environmental Research Laboratory (GLERL) in Ann Arbor. The AVHRR images were incorporated into a geographic information system (GIS) that combined sea surface temperature data with bathymetry to determine areas where zebra mussels are likely to colonize. Researchers also identified, based on cultural parameters (areas near urban expanses and river mouths), where *problem* areas are likely to be colonized.

The study demonstrates that CoastWatch data and GIS can be used to obtain quick first order identification of areas where zebra mussels are likely to colonize in large lakes or bays. Benefits to decision makers are that the results can be applied to establish monitoring locations or to decide which areas need further study. Such analyses are useful in reducing initial costs and increasing effectiveness.

NOAA COASTWATCH
SYNTHETIC APERTURE RADAR (SAR)

THE ISSUE:

Shipping, fishing, and recreational boating in areas where sea ice is prevalent can be treacherous and can constrain important economic activities in these areas. Accurate and dependable information about the location of sea ice and the presence of fronts, eddies, and currents is needed to help protect human lives from danger, to protect natural ecosystems from harmful spills due to boating accidents and collisions, and to facilitate economic activity in these areas.

THE APPROACH:

The ability of SAR instruments to view ocean, ice, and land surfaces at high resolution, day or night, and regardless of cloud cover makes this imagery a valuable tool for routine environmental monitoring. Sea ice applications of SAR data include measuring ice concentration, ice motion, detection of leads, iceberg tracking, and discrimination of ice type and age. Recent and near future launches of SAR instruments will make the data readily available. To prepare for the operational use of this data, the Coastal Ocean Program is supporting research for an applications demonstration of the use of SAR data in CoastWatch for the Alaska and Great Lakes regions.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

The July 1991 launch of the European Remote Sensing Satellite (ERS-1) satellite has made routine SAR data available. With the SAR's 30 meter resolution, ice-edge, lead, concentration, and iceberg locations will be much more accurate than can be obtained with the CoastWatch Advanced Very High Resolution Radar (AVHRR) resolution of 1.1 km. Open ocean applications of SAR for monitoring swell length and direction, the presence of fronts, eddies, and currents, and the extent of oil spills are also promising. The first year of the Alaska and Great Lakes applications demonstration project, begun in May 1992, assessed the usefulness of ERS-1 SAR data for CoastWatch management applications such as fisheries ecology, hazards to coastal transportation, assessment of ice jams and river flooding, and coastal ocean research. In FY93, an applications demonstration of the use of SAR data in CoastWatch was begun.

OCEAN COLOR
SEA-VIEWING WIDE FIELD-OF-VIEW SENSOR (SEAWIFS)

THE ISSUE:

The importance of remotely sensed ocean color data to understanding the ocean's role in coastal areas and in global biochemistry, climate, and change became apparent to the oceanographic community through retrospective analyses of Coastal Zone Color Scanner (CZCS) data. The Sea-Viewing Wide Field-of-View Sensor (SeaWiFS) will improve and renew this coastal ocean color remote sensing capability and will foster applications of SeaWiFS ocean color data to coastal science research efforts.

THE APPROACH:

COP's Ocean Color Project was initiated in FY 1993 to realize this coastal application by supporting the acquisition of high resolution coastal data at strategically located regional sites. The goal is to provide full coverage for the coastal U.S. The implementation of this project is designed around the following scientific objectives:

- to develop and validate regional coastal algorithms to improve the ability to use satellite data to estimate coastal ocean phytoplankton pigments, biomass, and ultimately productivity;

- to promote research aimed at improving the understanding of physical and biogeochemical processes in the coastal ocean, estuaries and Great Lakes; and

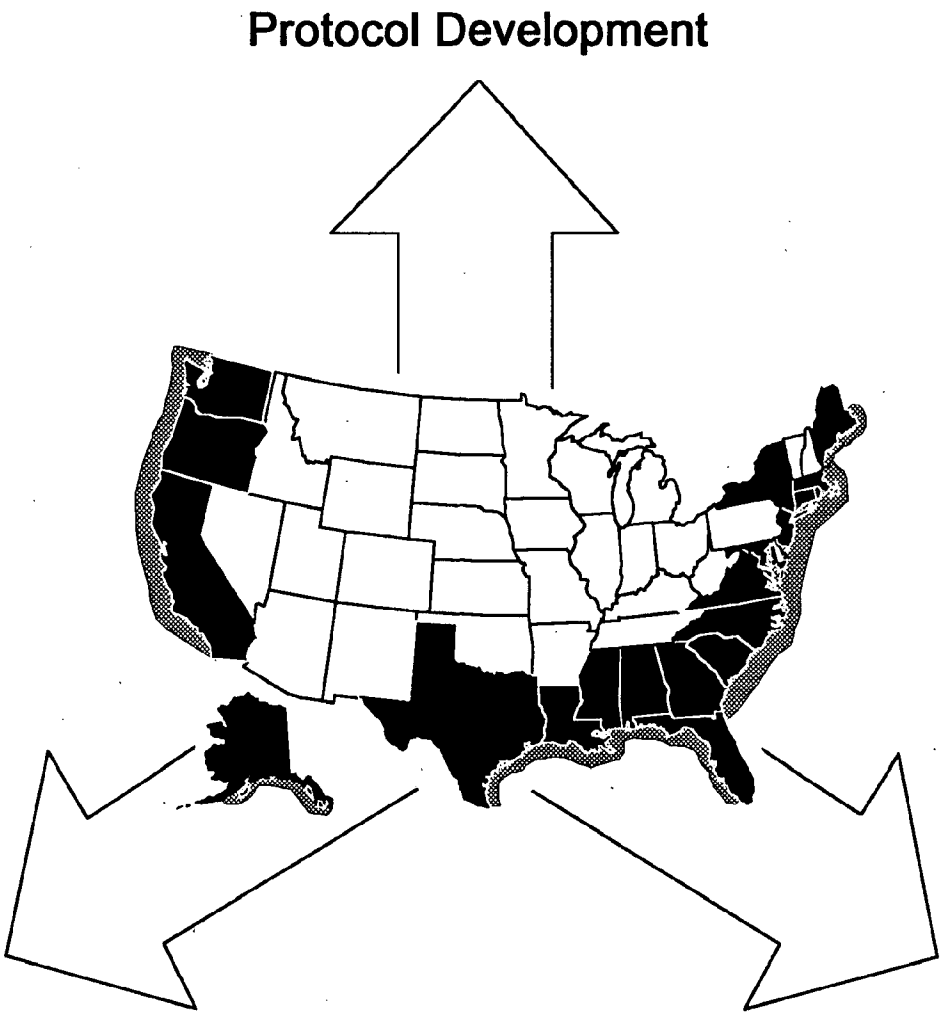
- to promote science application demonstrations utilizing ocean color data products to facilitate coastal resource and ecosystem management.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

The CZCS experience demonstrated that much of the scientific utility of ocean color data is realized in retrospective analysis. For this purpose, NOAA and NASA are working together to develop SeaWiFS, and COP is funding the development of a Collaborative Archive at Goddard Space Flight Center. The archive will receive high-resolution coastal SeaWiFS data collected from around the U.S. from the regional receiving, processing, and distribution facilities. Three NOAA locations have been identified as strategic acquisition sites for regional collaborative research, directed toward local coastal algorithm development of the coastal data. These sites, funded by COP, are also CoastWatch Regional Nodes and are located at the National Marine Fisheries Service laboratories in Honolulu, HI, and La Jolla, CA, and at Stennis Space Flight Center, MS. Plans are in development to establish a fourth strategic site before launch at the NWS Forecast Office in Anchorage, AK. Three components have been identified for the investigation plan, including SeaWiFS data operations, non-NOAA collaborative research and NOAA research applications.

NOAA COASTAL OCEAN PROGRAM

Coastal Change Analysis Program



COASTAL CHANGE ANALYSIS PROGRAM (C-CAP)

THE ISSUE:

Although over 70 percent of economically important fisheries in the U.S. depend upon estuarine habitats during some life stage, these areas are being destroyed or degraded by coastal development, bringing with it nonpoint source pollution, erosion, and environmental threats. Land cover changes due to human population growth and attendant impacts on fishery habitat, adjacent uplands, water quality, and living marine resources occur faster and more pervasively than we previously have been able to monitor. Information about the extent and rate of habitat degradation and loss is needed for sound resource management decisions.

THE APPROACH:

Quantifying changes in the areal extent of wetlands and adjacent uplands is critical for linking land-based human activities to coastal ocean productivity. The Coastal Change Analysis Program (C-CAP) uses satellite imagery and aerial photography to monitor areal extent, functional status and change in these critical habitats. C-CAP is cooperating with EPA's Environmental Monitoring and Assessment Program, the U.S. Fish and Wildlife Service's National Wetlands Inventory, the U.S. Geological Survey, and other Federal and State agencies. Currently, C-CAP is divided into three project areas: protocol development, regional change analysis, and remote sensing of wetland health.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

The program has developed a standard, nationally accepted protocol for mapping submerged aquatic vegetation (SAV), emergent coastal wetlands, and adjacent uplands. The protocol includes sources and procedures for data acquisition, processing, and presentation and has been tested and refined in two prototype studies, one in the Chesapeake Bay region and one in coastal North Carolina.

As the C-CAP protocol becomes more refined through research and input from regional projects, more effort is being focused on additional regional programs to expand the geographic coverage of the change detection database, including areal mapping of SAV. Researchers in Alaska, California, Florida, Georgia, Louisiana, Maine, Massachusetts, New Jersey, New York, North Carolina, Texas, Oregon, Washington, and Canada have initiated regional land cover and change detection studies.

A 1992 pilot study in Louisiana was conducted to determine the feasibility of remote sensing to measure the health of emergent wetland habitats. A final report relating spectral characteristics of marsh to aboveground biomass density is expected in 1994.

COASTAL CHANGE ANALYSIS PROGRAM (C-CAP) NATIONAL PROTOCOL DEVELOPMENT

THE ISSUE:

Changes due to human population growth and attendant impacts on fishery habitat, adjacent uplands, water quality, and living marine resources are occurring very quickly. Monitoring these changes too often produces data and tools that are difficult for decision makers to use because of the complexities in understanding what these data mean. A standard protocol for detecting change in emergent coastal wetlands, adjacent uplands and submersed habitats is needed for producing comparable products that managers can use in making natural resource decisions.

THE APPROACH:

Development of the C-CAP protocol is based primarily on information generated by five regional workshops, topical meetings, and two prototype studies, one in the Chesapeake Bay region and the other in coastal North Carolina. The prototype studies used Landsat Thematic Mapper (TM) imagery, aerial photography and field verification. Researchers from universities, State and regional organizations, the Oak Ridge National Laboratory, and NOAA have participated in this development. The protocol includes sources and procedures for data acquisition, processing, and presentation. Nationwide acceptance of the protocol will allow comparable data to be obtained regardless of the agency which funded or conducted the effort.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Issues dealing with statistical validation and the development of a classification scheme for wetlands and uplands played a large role in protocol development as did the two prototype studies. The Chesapeake Bay was used as a prototype for change detection of emergent wetlands and uplands using satellite imagery, while coastal North Carolina was used as a prototype for mapping and change detection of submerged aquatic vegetation using aerial photography. Findings from these studies and from a field test in Salisbury, MD, have prompted C-CAP to fund projects to both expand the geographic coverage of the database and refine various aspects of the protocol. Some of the refinements include testing change detection methodology, examining the influence of tides on TM data, and the development of improved methodology for detecting certain types of wetlands and for accuracy assessment of the change detection databases. The protocol will be published as a NOAA Technical Report in 1994.

COASTAL CHANGE ANALYSIS PROGRAM (C-CAP) CHESAPEAKE BAY REGION

THE ISSUE:

Land cover changes due to human population growth and attendant impacts on fishery habitat, adjacent uplands, water quality, and living marine resources occur faster and more pervasively than we previously have been able to monitor. Information about the extent and rate of these land-cover changes, habitat degradation and loss, and the effects of nonpoint source pollution is needed for sound resource management decisions.

THE APPROACH:

A prototype change analysis for land cover in the Chesapeake Bay region was conducted by researchers at Oak Ridge National Laboratory as part of an effort to develop a standard, nationally accepted protocol for mapping emergent coastal wetlands and adjacent uplands. The study compared Landsat Thematic Mapper imagery for 1984 and 1988/89. Nationwide acceptance of the protocol will allow comparable data to be obtained regardless of agency which funded or conducted the effort.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

The Chesapeake Bay data set constitutes one of the largest change detection efforts ever attempted, covering an area of approximately 30,000 square miles. Its greatest value is in its synoptic coverage and consistent classification over such a large area. The data set has been refined through a series of field and statistical validation projects consisting of: 1) initial field tests with existing wetlands data, including U.S. Fish and Wildlife Service's National Wetlands Inventory map products; 2) preliminary field tests by Federal, State and local experts for the Salisbury, MD area; 3) an error estimation workshop to design an accuracy assessment approach for habitat change analysis; and 4) an accuracy assessment of the data set based on the findings of the above workshop and field work.

As part of an effort by the wetlands subcommittee of the Federal Geographic Data Committee, a field verification of the Wicomico County portion of the data set was conducted in 1993 in order to identify the level of consistency between wetlands data collected by various government agencies and to determine cause of possible inconsistencies. U.S. Geological Survey's Eastern Mapping Center implemented the analysis through the use of geographic information system technology. Preliminary findings suggest that C-CAP data for forested wetlands are more accurate than previously thought. A final report of the Wicomico effort is scheduled for release in 1994.

In order to expand coverage in the region, the Coastal Ocean Program is supporting the process of merging land use/land cover maps from the northern North Carolina coast with those produced for the Chesapeake Bay region.

COASTAL CHANGE ANALYSIS PROGRAM (C-CAP)
NORTH CAROLINA

THE ISSUE:

Submerged aquatic vegetation (SAV) includes some of the most productive primary producers in the marine environment and provides habitat for juveniles and adults of many estuarine dependent fish and shellfish. SAV has been vulnerable to adverse effects from anthropogenic activities in the North Carolina coastal zone. These activities include the increasing development of coastal wetlands and adjacent uplands, excessive freshwater inflow, pollution, and turbidity. Data on spatial change of seagrass habitat is needed to improve the management of these habitats and the species they support.

THE APPROACH:

A prototype change analysis for SAV along the North Carolina coast was carried out in order to develop a standard, nationally accepted protocol for mapping these habitats. Nationwide acceptance of the protocol will allow comparable data to be obtained regardless of the agency which funded or conducted the effort. C-CAP SAV efforts in North Carolina were co-funded by the Albemarle-Pamlico Estuary Study of the EPA National Estuary Program.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

The National Marine Fisheries Service (NMFS) Beaufort Laboratory completed its effort to map SAV along the North Carolina coast from Bogue Inlet to the Virginia border with change analysis conducted from Cape Lookout to Drum Inlet for 1985-88. SAV habitat charts were published for southern and northern Core Sound and southeast Pamlico Sound as well as a change detection map for southern Core Sound.

Through this effort, researchers at the NMFS Beaufort Laboratory have refined change detection methodologies for SAV. Global Positioning System technology also has been used to verify locational information. Personnel from Oak Ridge National Laboratory are also assisting researchers at North Carolina State University to merge the land use/land cover maps from northeastern North Carolina with those produced for the Chesapeake Bay region. In 1994, effort is being focusing on building a standardized, digital, regional land cover change detection database for all of coastal North Carolina. The change detection will use Landsat Thematic Mapper (TM) data and will reflect land cover changes from the 1987-90 time frame to contemporary TM data (1993/94).

The North Carolina Department of Environment, Health and Natural Resources will continue to incorporate these data into its geographic information system database in order to resolve fishery questions related to land development, water rights, etc. The State, using this data, has established certain coastal water bodies as outstanding resource waters deserving extra protection.

COASTAL CHANGE ANALYSIS PROGRAM (C-CAP)
GULF OF MEXICO

THE ISSUE:

Marsh habitat loss in the Gulf of Mexico is a prevalent problem. Wetland areas including the Galveston Bay area, Sabin Lake wetlands, Bessie Heights Marsh, Port Arthur, and Corpus Christi area are suffering from both subsidence and salt water intrusion. The causes of these can be attributed to oil pumping activity as well as to groundwater extraction to meet the demands of a growing population along the coast as well as further inland where freshwater is scarce. Adding to these problems are the attendant habitat alterations and nonpoint source pollution associated with population growth along the coast.

THE APPROACH:

In FY 1991, C-CAP began a cooperative project with the State of Texas to perform a change detection analysis for emergent wetlands and adjacent uplands for two initial Landsat Thematic Mapper scenes in the Galveston Bay area. This work is being expanded to include additional scenes along the Gulf of Mexico coast. The Texas Parks and Wildlife Department is performing the image processing following the guidelines of the C-CAP protocol with technical assistance from Oak Ridge National Laboratory.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

In FY93, C-CAP purchased a 1992 Landsat scene for one side of the Bay, and in 1994 the State of Texas completed a 1988-1992 change analysis. At the end of 1993, surveying started in the Sabin Lake wetlands area where marsh acreage has been undergoing losses for the past five years. Work continues on the imagery for the area and preliminary groundtruthing has been completed. Maps are expected in the summer of 1994. In August of 1994, change detection analyses will begin for the Corpus Christi area where the growing demand for water is threatening the functional health of the Natches River and estuary.

COASTAL CHANGE ANALYSIS PROGRAM (C-CAP)
MAINE AND CANADA

THE ISSUE:

The St. Croix River historically has provided valuable habitat for salmon. Land use changes from the large forestry industry in both Maine and Canada have threatened this habitat. The logging facilitates runoff of sediment, damages the river's clarity and depth, and inhibits the ability for the salmon to survive upstream. Also damaging the quality of the St. Croix River and Passamaquoddy Bay is human development that contributes other nonpoint source pollutants from septic tanks, urban runoff, etc. Understanding how and where these types of land use changes are occurring can help managers ameliorate the damage and prevent further degradation.

THE APPROACH:

At the end of FY92, a regional change analysis project in the St. Croix River estuary and Passamaquoddy Bay in Maine and Canada was initiated using the C-CAP protocol. This is a cooperative effort involving C-CAP, the U.S. Fish and Wildlife Service, the Gulf of Maine Program, and Environment Canada.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

A change analysis will be completed using Landsat Thematic Mapper imagery from 1985 to 1992. In FY93, the following was accomplished: 1) image acquisition; 2) preliminary image analysis; 3) initial field verification; and 4) production of preliminary map products to be used in upcoming field verification work. Image analysis and field verification will continue and a final change detection product will be available late in 1994. Researchers at the University of Maine have contributed to the change detection protocol development by improving methodologies for detecting forested wetlands.

COASTAL CHANGE ANALYSIS PROGRAM (C-CAP)
OREGON AND WASHINGTON

THE ISSUE:

Land use changes from the forestry industry in both Oregon and Washington are seriously affecting the functional integrity of fishery habitat in the Columbia River. Sedimentation from logging clouds the streams and reduces depth, especially in the small tributaries of the Columbia River that are essential to salmon spawning. This runoff also adversely effects the coastal bays where productive shellfish beds lie. By analyzing these land use changes, managers can perhaps improve techniques that will protect these habitats as well as ensure the economic productivity of the fishing and shellfish harvests.

THE APPROACH:

Protection of salmon stocks is one of the critical elements related to C-CAP's involvement in habitat mapping. At the end of FY92, C-CAP initiated a regional change analysis project in the lower Columbia River, Willapa Bay, and Tillamook Bay and in 1994 initiated a seagrass mapping initiative in Willapa Bay. This is a cooperative effort involving the National Marine Fisheries Service Point Adams Field Station in Hammond, OR, NOAA Office of Coastal Resource Management, the cooperating agencies within the Columbia River Estuary Study Task Force (CREST), and the States of Oregon and Washington.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

In FY93, the following was accomplished for the regional change analysis: 1) image acquisition; 2) preliminary image analysis; 3) initial field verification; and 4) production of preliminary map products to be used in upcoming field verification work. Image analysis and field verification will continue and a final change detection product will be available by the summer of 1994. A workshop to demonstrate the product to State, regional, and Federal groups is planned.

CREST, as an outgrowth of this change analysis mapping, is initiating a project to map the distribution of seagrasses in Willapa Bay. These baseline maps will be used to monitor the effects of management decisions such as nonpoint source pollution reduction strategies on the seagrass *Zostera*. The project will test the C-CAP mapping protocol on the West Coast and will use aerial photographs, photointerpretation, and field monitoring to develop the digital and hard copy maps that will be made available to regional resource managers. Expected completion date for the project is September 1996.

COASTAL CHANGE ANALYSIS PROGRAM (C-CAP)
ALASKA

THE ISSUE:

The Hubbard Glacier in Alaska is moving very rapidly and within the next ten years is threatening to close off the Russell Fiord which provides important habitat for a variety of marine life. More importantly, if the Hubbard Glacier does indeed trap the Fiord, the water level will rise within the Fiord and may cause the water to discharge elsewhere. This would adversely affect the Situk River, an important run for the area's salmon fishery. The logging industry has also had multiple effects on these stream ecosystems and salmon fisheries through its effects on the riparian zone and on upland areas.

THE APPROACH:

At the end of FY92, C-CAP initiated a mapping effort in the area of Hubbard Glacier and Russell Fiord. This is a cooperative effort involving the National Marine Fisheries Service Auke Bay Laboratory. Cloud cover problems in this area have made image acquisition difficult. The present effort is being conducted with a 1986 Landsat Thematic Mapper image. C-CAP is searching for a more recent image to conduct a change analysis. It is hoped that if the glacier does close off the fiord, another image can be obtained to monitor the effects of rising water on surrounding habitats and the Situk River.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

In FY93, the following was accomplished for the regional change analysis: 1) image acquisition; 2) preliminary image analysis; 3) initial field verification; and 4) production of preliminary map products to be used in upcoming field verification work. Image analysis and field verification will continue and a final change detection product will be available by the summer of 1994.

COASTAL CHANGE ANALYSIS PROGRAM (C-CAP)
SOUTHERN FLORIDA

THE ISSUE:

Seagrass habitats in South Florida have been extensively modified by human development and from the freshwater flow alterations through the Everglades. Florida Bay, in particular, is suffering extensive ecological damage from this alteration of freshwater flow. The lack of freshwater has changed the salinity content of the water, thus shifting the seagrass species composition and causing seagrass die offs. This then facilitates a spiral effect as the increased turbidity and phytoplankton blooms from these changes increase the likelihood for further seagrass die offs.

THE APPROACH:

In response to the dramatic declines in submerged seagrass beds in South Florida and Florida Bay, research has been initiated to focus on better understanding the primary factors that control seagrass distribution and productivity (e.g., water clarity and nutrients), on developing better methodologies for creating or evaluating newly constructed seagrass ecosystems, and on methodologies to map, monitor, and assess the health of seagrass ecosystems.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

C-CAP principal investigators have been assisting the Florida Department of Environmental Protection to determine status and the health of the southern Florida ecosystem by helping to interpret aerial photography to map seagrass beds in Florida Bay. A project using Landsat Thematic Mapper imagery to map emergent wetlands is also in the planning stage. These maps will help to pinpoint where restoration efforts and better management practices are needed. This project is being conducted under the auspices of the Federal Geographic Data Committee and is bringing together Federal, State, and local agencies that have digital spatial data for South Florida. The goal of the project is to utilize these data to help answer pertinent management questions.

Work on an inventory of seagrass habitats in Florida Bay will also be conducted in 1994. The data source is aerial photographs acquired through a photo mission funded jointly by C-CAP and the State of Florida and conducted by the NOAA Photogrammetry Unit. Photographic data will be supplemented and verified with field data to be collected this year. This effort is part of a larger South Florida project to perform a comprehensive inventory of an extremely valuable resource threatened by an ongoing die-off of seagrasses and reduction in associated fisheries.

COASTAL CHANGE ANALYSIS PROGRAM (C-CAP)
MASSACHUSETTS

THE ISSUE:

The coastal areas of Massachusetts are highly developed and thus contribute many point and nonpoint source pollutants into the estuarine habitats and bays. The results of this pollution are evidenced by wetland and seagrass habitat reduction. One example of this is in Boston Harbor where the sewage discharges are one of the major causes of environmental degradation and where very little of the historic level of seagrasses still remains healthy. By mapping seagrass habitat, managers can hopefully track the environmental health of the area and can use these seagrasses as an indicator of success for management decisions.

THE APPROACH:

Studies of seagrass habitats have been initiated in response to this dramatic decline in submerged seagrass beds around the Massachusetts coastline. Research in Massachusetts is focused on understanding the primary factors that control seagrass distribution and productivity (e.g., water clarity and nutrients), on developing better methodologies for creating or evaluating newly constructed seagrass ecosystems, and on using seagrass distribution and productivity as an indicator of ecosystem health.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Submerged aquatic vegetation (SAV) mapping of coastal Massachusetts is a cooperative effort involving the Massachusetts Department of Environmental Protection (DEP). The State is developing a multipurpose wetlands inventory. During 1993, photography was flown for preliminary test areas in Buzzards and Massachusetts Bays. Additionally, C-CAP personnel have instructed DEP personnel in the use of C-CAP protocols for mapping SAV and in the procedure for conducting preliminary field investigations in the test areas. Final map products for the Buzzards Bay test site are available, while final map products for the Massachusetts Bay test sites will be made available in the summer of 1994. Another project for mapping SAV near Nantucket Island and the north shore of Cape Cod has already begun. This project is a cooperative effort between C-CAP, DEP, and the Woods Hole Oceanographic Institution. Field verification, photointerpretation and compilation will take place in 1994. In addition to the DEP, the State Office of Coastal Zone Management, the Division of Marine Fisheries, and the Department of Environmental Management will also use the data.

COASTAL CHANGE ANALYSIS PROGRAM (C-CAP)
LOUISIANA

THE ISSUE:

Historically, the coastal marshes of Louisiana have been the recipient of plentiful supplies of sediment from the Mississippi River. The series of dikes built to protect the growing populations along the River, however, have retained the majority of this sediment essential for the functional health of these coastal marshes. The wetlands have, therefore, undergone sediment starvation, resulting in marsh sediment settlement and subsidence and altering the functional capacity of the coastal marshes in Louisiana.

THE APPROACH:

In addition to change detection analysis, C-CAP is also interested in developing new and easier techniques for mapping and measuring the health of emergent wetland habitats. A feasibility study was funded in Louisiana to determine if this monitoring can be made from using remotely sensed data. This is a cooperative effort between the University of Delaware and Louisiana State University. C-CAP is also working with NOAA's Coastal Ocean Program and Office of Coastal Resource Management to build a geographic information system (GIS) to detect land cover changes along the Louisiana coast.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

As a preliminary effort in this study, scientists at the University of Delaware completed in FY92 a literature search and review to summarize the feasibility of remotely sensing biomass, productivity, and functional health of coastal marshes. Also in FY92, a pilot study in Louisiana marshes was conducted jointly by scientists from the University of Delaware and Louisiana State University (the latter funded by EPA's Environmental Mapping and Assessment Program) to relate spectral characteristics of marsh to above ground biomass density. To date, relative biomass maps have been completed, but the more difficult task of coordinating the calibration of the remotely sensed data to field data is still underway. Work is also continuing to correct the model in order to accurately characterize surface features for the mapping. A final report is expected in 1994.

In cooperation with this remote sensing effort, the National Wetland Research Center is building a comprehensive standardized GIS to detect and assess changes in land cover and habitat in the Mermentau River Basin and within the Chenier Plain of coastal Louisiana. Imagery sources include Landsat Thematic Mapper (TM) data and photography. C-CAP protocols will be used to classify the TM data with the 1993/94 images providing the base and 1990 images providing the change comparison. Field data will also be collected to verify the classifications made from the imagery. Results for this study will provide a baseline for change detection and a standard format for incorporating databases and results from current programs and future data sources. It will especially benefit development of Louisiana's coastal nonpoint source program and will provide baseline information and protocols with Gulf-wide or national applications.

COASTAL CHANGE ANALYSIS PROGRAM (C-CAP)
GEORGIA

THE ISSUE:

The salt marshes, brackish marshes, and tidal swamps that line the Georgia coast between the mainland and the barrier islands are vital ecosystems that buffer upland run-off to the coastal estuaries and provide habitat for fish and shellfish populations. The entire coast, however, faces development pressure from a rapidly growing State population and nonpoint sources of pollution due to important agriculture and forestry activities.

APPROACH:

C-CAP in cooperation with NOAA's Coastal Ocean Program and Office of Coastal Resource Management has initiated a one-year project with the University of Georgia's Center for Remote Sensing and Mapping Science (CRMS) to collect land cover/habitat information for the coastal and adjacent upland areas of the Georgia coast over a 10-year period. Georgia data will be used to expand C-CAP's digital database on the southeastern Atlantic coastal zone area.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

CRMS and C-CAP hope to develop a digital database and employ geographic information system technology for Georgia coastal change analysis over the ten-year period from 1984-1994. Historical imagery of coastal wetlands and adjacent uplands will be obtained from 1984 Landsat Thematic Mapper (TM) data and 1983 aerial photography, and the 1993/94 baseline will be obtained from TM data and aerial photography. Field work will be conducted to verify the classifications made from the imagery. Color-coded hard copy maps and digital datasets depicting coastal land cover change between 1984-1994 will be developed by the project and will be made available to resource managers responsible for management decisions affecting the Georgia coast.

COASTAL CHANGE ANALYSIS PROGRAM (C-CAP)
NEW YORK

THE ISSUE:

Measuring the success of the Coastal Zone Management Act Section 6217, Coastal Nonpoint Contamination Program, can be done by monitoring the health and distribution of coastal wetlands, adjacent uplands, and submerged aquatic vegetation (SAV). A baseline knowledge of the current conditions are therefore needed on which to measure changes. Knowledge, however, of the current distribution and species composition of SAV in the Hudson River is site-specific and incomplete, and on Long Island, no digital database exists documenting wetland and upland areas.

APPROACH:

C-CAP, in cooperation with NOAA's Coastal Ocean Program and Office of Coastal Resource Management, initiated two projects in New York in 1994: 1) large-scale mapping of the current distribution and species composition of SAV in the Hudson River; and 2) establishing a digital database for coastal wetlands and adjacent uplands for Long Island Sound. The New York Sea Grant College Program is conducting the SAV mapping study using aerial photography and field verification. The New York State Coastal Management Program is looking at change in emergent wetlands and uplands using Landsat Thematic Mapper imagery, aerial photography, and field verification.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Two final products are expected from the 2-year SAV project: 1) 9" x 9" true color photographic prints and transparencies at the scale of 1:24,000 and 2) NOAA shoreline maps at the scale 1:20,000 upon which the database of community composition and distribution of SAV have been mapped. The SAV data will also be provided in digital format.

For Long Island, digital and hard copy maps will be created. The digital database will use 1994 as the base year and will be updated at five year intervals. It will be used by New York State and regional agencies to assess current wetland and watershed conditions and characteristics and for future change detection efforts. Use of the resulting database will be facilitated by developing a protocol for and sample output of data files for input to selected regional geographic information system (GIS) platforms. In addition, this remote sensing database will be incorporated into existing and planned wetland-related GIS databases.

COASTAL CHANGE ANALYSIS PROGRAM (C-CAP)
NEW JERSEY

THE ISSUE:

New Jersey is the most heavily urbanized State in the nation. Its coastal zone has experienced tremendous development in the last two decades. The loss of coastal wetland and upland habitat and the increase of nonpoint source pollution has negatively affected adjacent estuarine systems, leading to a decrease in productivity and biodiversity.

APPROACH:

In 1994, C-CAP, with the cooperation of NOAA's Coastal Ocean Program and Office of Coastal Resource Management, initiated with the New Jersey Sea Grant College Program a project to expand the C-CAP database coverage. The goal of the project is to develop a standardized information base on the present land cover of the New Jersey Atlantic Outer Coastal Plain to serve as the basis of future C-CAP change detection efforts.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Evaluation of the utility of established C-CAP protocols to New Jersey's heavily urbanized coastal zone will include classifying summer 1994 Landsat Thematic Mapper (TM) imagery using the C-CAP Land Cover Classification System. The project will investigate the incorporation of additional data sets such as the U.S. Fish and Wildlife Service's National Wetlands Inventory and/or soil maps in the context of a geographic information system (GIS) to provide further classification improvement. Also, a retrospective change detection analysis using TM imagery from 1984, 1988, and 1992 for the New Jersey coastal region that spans a gradient of human disturbance will be conducted.

The products developed from the project will be shared with the New Jersey Department of Environmental Protection and Energy and will be integrated into the New Jersey Ecological Spatial Data Base Project that is being developed, maintained, and distributed by the Rutgers University Center for Remote Sensing and Spatial Analysis.

COASTAL CHANGE ANALYSIS PROGRAM (C-CAP)
CENTRAL CALIFORNIA COAST

THE ISSUE:

Along the West Coast of the U.S., California contains more coastal wetland acreage than Oregon or Washington. However, California has lost 75% of its original coastal wetlands. Rapid population growth, freshwater diversions, increase in urban/agricultural run-off, and destruction of natural habitat has a direct effect on the extent of sensitive habitat, species, and water quality. The cumulative effect of these impacts upon the remaining wetlands is not well understood on a regional watershed basis.

APPROACH:

In 1994, C-CAP, in cooperation with NOAA's Coastal Ocean Program and Office of Coastal Resource Management, initiated a study with the California Coastal Commission to test the applicability of the C-CAP protocol in a West Coast wetland ecosystem by the classification of Landsat Thematic Mapper (TM) data and visualization of C-CAP products.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Objectives of the project are: 1) to determine TM data capabilities and limitations for land cover identification and mapping, with particular emphasis on wetland habitats in the Elkhorn Slough watershed; 2) to develop a land cover database of the Elkhorn Slough drainage area for two dates of TM imagery; 3) to demonstrate the integration of C-CAP digital products with existing geographic information system databases for cumulative impact assessment, control of nonpoint source pollution, and pollutant loading models; and 4) to identify the utility of the C-CAP protocol products for long-term monitoring and assessment of cumulative impacts, particularly with respect to nonpoint source pollution monitoring requirements of CZARA Section 6217, and to cumulative impact monitoring of CZMA Section 309.

Expected results include a quantified geographically specific land cover change for the entire Elkhorn Slough watershed between 1985 and 1993, identification of spatial and spectral limitations of the TM data for land cover inventory in terms of a minimum measurement unit for California wetlands, and the identification of the potential usefulness of the C-CAP data for cumulative impact assessment and monitoring of nonpoint source pollution.

Results of the study will be provided to C-CAP and the California Coastal Commission in the form of digital land cover databases, land cover change databases, ground observation coordinates, accuracy assessment matrixes, and ancillary data necessary for file management and archiving. A full report of the findings will be presented, and a local demonstration workshop will be held to present the findings and the application of C-CAP land cover change data in visualization of pollutant data within the watershed.

NOAA COASTAL OCEAN PROGRAM

Estuarine Habitat Program

- ★ Restoration Technologies
- ★ Functional Value Comparisons
- ★ Landscape Ecology
- ★ Integrated Modeling

ESTUARINE HABITAT PROGRAM (EHP)

THE ISSUE:

It is estimated that three-quarters of the Nation's marine harvestable species are at some point in their life cycle dependent on estuarine habitats for food and shelter or as migratory routes and spawning grounds. Generally, estuarine habitat is being lost or degraded in direct proportion to human population density in coastal areas and at rates that concern coastal scientists and mangers. Much of the decline of salt marsh and seagrass systems has been through some type of alteration to the flow of water to these habitats, such as dams, levees, dikes, dredge and fill operation, drainage, roadways, etc. It is important for resource managers to understand the importance of these habitats to the long-term support of fish populations. A better understanding of the location, extent, and rate at which critical habitats are being altered will provide managers with an enhanced ability to improve habitat and fishery restoration and management techniques and thus maximize social and economic benefits to the Nation.

THE APPROACH:

EHP research is centered on specific seagrass or salt marsh habitats and is focused on understanding the mechanisms and impacts of habitat alteration and restoration, the functional value and role of these habitats, and the linkages between these habitats. Another focus for research is the development of spatially based, generic, functional ecosystem model applications to seagrass and salt marsh habitats that couple relatively small-scale models to landscape- or regional-scale spatial models. These models can provide for the integration of EHP functional research with mapping and geographic information system (GIS) information in order to analyze regional-scale changes on living marine resources.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Research on salt marsh and seagrass environments has produced a body of knowledge that contributes to a better understanding of the these habitats, and how they can be maintained or restored. Manuals that help determine the structure and functional health of natural and restored wetlands have been produced, as has a document examining the capability of water quality criteria to protect seagrasses. With the progress made in these two areas, a 1992 workshop recommended that greater emphasis be placed on the impact of seagrass and wetland habitats on living marine resources; the interaction of these habitats with surrounding habitats; and the integration of the habitat function research results with the Coastal Change Analysis Program (C-CAP) change detection analyses. As a result, the mix of fourteen current EHP projects is highly weighted toward innovative approaches. Four of the five Restoration Technology projects deal with genetic variability. Two projects relate to Functional Value, one of which is specifically aimed at comparing various habitats for their functional value as nursery areas for fish recruitment. Five projects deal with various aspects of Landscape Ecology, one of which is focusing on the critical area of the Columbia River Estuary. Two projects are dealing with Integrative Modeling. Several of the projects across the categories will employ C-CAP analyses as part of their activity.

ESTUARINE HABITAT PROGRAM
RESTORATION TECHNOLOGY
IMPROVING METHODS FOR WEST COAST MARSHES

THE ISSUE:

The ultimate goal of wetland restoration is to provide self-sustaining ecosystems that closely resemble the natural systems being replaced in terms of both structure and function. Southern California's salt marsh restoration sites do not function as well as natural wetlands. A 1992 transplantation of approximately 11,000 plugs of cordgrass at the Santa Ana River mouth (near Los Angeles) experienced 100 percent mortality; in San Diego Bay, the three marshes that were planted to attract Light-footed Clapper Rails to nest have failed to attract this endangered bird. New methods are needed to improve the success of coastal wetland restoration, and the resulting information needs to be transferred to users.

THE APPROACH:

The overall goal of this project is to improve the potential for habitat construction and manipulation to produce functional ecosystems more rapidly. Researchers in southern California are conducting studies with the following objectives: 1) measuring rates of ecosystem development in constructed wetlands by comparing sites of different age and comparing individual sites through time; and 2) looking at ways to accelerate ecosystem development of constructed wetlands by augmenting soils with organic matter and nitrogen.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

To date, the research has shown that cordgrass in constructed west coast marshes is too short to function as suitable nesting areas for clapper rails, but that nitrogen addition can improve the cordgrass growth. Scale insects can become serious pests in some of the constructed marshes, causing significant damage to the cordgrass, and research is underway to determine how to avoid the problem. Products generated by this project include a book of guidelines on salt marsh restoration.

ESTUARINE HABITAT PROGRAM
RESTORATION TECHNOLOGY
GENETIC DIVERSITY IN CALIFORNIA SEAGRASS BEDS

THE ISSUE:

To provide continued support for living marine resources, seagrass populations must remain viable. In southern California, transplanted seagrass beds have been found to have reduced genetic diversity relative to beds with no known history of transplantation, although they are undoubtedly stressed. Genetic diversity is essential to the long-term survival of populations, providing the variation necessary for adaptation to new environmental conditions, including marine pollution. Despite the ecological importance of aquatic plants, their population biology, particularly population genetics, is relatively unknown. The genetic approach is important because it provides a tool for predicting whether current reductions in seagrass populations are likely to result in future losses.

THE APPROACH:

The goal of this project is to determine the degree of genetic diversity necessary to ensure survival of transplanted eelgrass beds over a desirable time frame. Researchers in southern California are conducting studies to determine why transplanted eelgrass beds are deficient in genetic diversity compared to natural beds; whether reduced genetic diversity is a local phenomenon; the mechanisms creating the deficit; and the significance of reduced genetic diversity for eelgrass bed development, maintenance, and persistence, and the ecological consequences. This approach provides practical ways in which seagrass viability can be increased and restoration success maximized.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

The project will use the information generated to develop management strategies that preserve natural levels of genetic diversity in eelgrass populations so that long-term viability, and thus associated living marine resources, is not compromised. To this effect, the project is developing recommendations on the population size and levels of genetic diversity to include in eelgrass transplantations to ensure reasonably long-term persistence and adjustment to environmental changes. In addition, the project will provide a demographic model to predict eelgrass bed development and recommendations on possible revisions of permit requirements for eelgrass habitat modifications.

ESTUARINE HABITAT PROGRAM
RESTORATION TECHNOLOGY
GENETIC DIVERSITY OF FLORIDA/CARIBBEAN TURTLE GRASS

THE ISSUE:

Seagrass communities exert a major influence on estuarine and coastal environments because of their rapid growth and high net productivity. Turtle grass, *Thalassia testudinum*, dominates the shallow coastal and estuarine communities of the Gulf of Mexico and Caribbean and serves as a nursery and habitat for a wide variety of fishes and crustaceans. Vegetative propagation appears to be the primary method used by most seagrasses to expand, resulting in genetic uniformity that can result in communities that are vulnerable to disease or environmental changes such as global warming. There is a need to know the amount of genetic diversity that exists between and within beds of *T. testudinum*, and whether this diversity is correlated to specific locations and abiotic factors, in order to ensure that restoration projects using turtle grass, or other seagrass species, will achieve a higher success rate by using clones of individual plants that are compatible with the mitigated site.

THE APPROACH:

The overall goal of this project is to assess the genetic diversity of *T. testudinum* in Florida and the Caribbean. Researchers in Florida are conducting a systematic examination of the genetic diversity of populations of *T. testudinum* on the west coast of Florida, the Florida Keys, and the Caribbean island of Jamaica using anonymous nuclear DNA markers. The work includes a determination of the genetic separation of populations, genetic diversity of individuals growing in similar, local habitats and a correlation of the genetic information with morphology and habitat.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Most importantly, the study should yield insights into the significance of the clonal nature of turtle grass beds. The procedures developed for genetic differentiation of *T. testudinum* would give managers of coastal systems tools to determine genetic diversity in other species of seagrasses as well. This determination of genetic diversity will aid in strain selection for mitigation projects. Ultimately, a genomic library will be constructed to support future activities.

ESTUARINE HABITAT PROGRAM
RESTORATION TECHNOLOGY
GENETIC CHARACTERIZATION/EAST COAST SEAGRASS PROPAGATION TECHNIQUES

THE ISSUE:

Marine habitat restoration is important from recreational, ecological, and fisheries perspectives. A number of techniques have been developed for planting marine seagrasses, and protecting them during the initial stages of establishment. Concerns have developed over the quality and sources of the transplants, and the environmental effects of disturbing donor beds for transplant material. Over the last few years, researchers have been developing methods for horticultural propagation of seagrasses, with the primary focus on *in vitro* propagation, which offers a potentially low-cost, highly efficient technique at rates that are much higher than those obtained from other methods of propagation.

THE APPROACH:

The overall goal of this project is to develop techniques for *in vitro* propagation of seagrasses. Researchers in North Carolina and Florida are collaborating to further develop both *in vitro* propagation technology for seagrasses and procedures for transplanting cultured plants to the field. In addition, data will be collected on the productivity of seagrasses in more diverse field locations. A second focus is to begin to characterize the degree of genetic diversity that occurs within two seagrass species, eelgrass *Zostera marina* and shoal grass *Halodule wrightii* in the Chesapeake Bay region.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

New methods for seagrass habitat restoration and creation based on a biotechnological approach will be developed. This new technology could be used to produce large numbers of plants for seagrass restoration projects and provide information towards filling gaps in our knowledge on how to achieve effective habitat restoration. In addition, the project will develop a genotype map of *Z. marina* for the Chesapeake Bay region to characterize degree of genetic diversity. Genotype maps can be integrated within remote sensing programs (such as the Coastal Change Analysis Program) and GIS models to help predict best management practices to maintain genetic diversity of seagrass populations.

ESTUARINE HABITAT PROGRAM
RESTORATION TECHNOLOGY
DELAWARE MARSHES

THE ISSUE:

The goal of wetland creation and replenishment is the enhancement of valuable wetland functions by restoring wetland ecosystems that have been damaged and by creating new communities from other more abundant or less critical habitats. To this effect, high performance varieties (i.e., genotypes) of plant species that can accelerate and sustain the functional efficiency of created and restored marshes are needed. Research has identified different varieties of the salt marsh plant *Spartina alterniflora* that have different functional potentials (capacity to support living marine resources) that directly or indirectly affect the degree of planted marsh development. The next step is to determine if the different potentials exhibited by plant varieties result in different realized support functional levels for living marine resources.

THE APPROACH:

The overall goal of this project is to identify the impact of the varieties of native salt marsh plants on marsh support functions and to develop varieties of salt marsh grasses with properties most desirable for restoration. Researchers in Delaware are comparing the functional potential of *S. alterniflora* varieties by using a series of models to assess changes in potential for living marine resources support functions through time as the planted marsh develops, measuring how plastic the varieties of *S. alterniflora* are in their growth patterns in several geographic locations, examining and comparing the natural genetic variability available for selecting varieties of *S. foliosa* collected on the California coast, and determining if the different potentials exhibited by the plant varieties result in different realized support functional levels for living marine resources.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Products will include information on the effect of plant varieties of *S. alterniflora* on fish utilization of the marsh surface and on the rate of development of created marshes to achieve functional equivalency with natural salt marshes. In addition, simulation models for the various wetlands will provide comparative projections on the potential of each variety to influence the rate of development of wetland functions, thereby providing a format for future comparisons as other varieties or species are studied.

ESTUARINE HABITAT PROGRAM
FUNCTIONAL VALUE
NORTHEASTERN FISHERIES RECRUITMENT

THE ISSUE:

Significant gaps exist in our knowledge of how estuarine habitats are utilized by many resource species and how habitat quality affects recruitment success. This is especially true for the recently settled juveniles of many species that are the basis for commercial and recreational fisheries. This type of information is critical to our ability to rationally manage these resources.

THE APPROACH:

The overall goal of this project is to identify critical habitats for fishes in northeastern estuaries and assess their functional value as nurseries. Researchers from New Jersey and NOAA are collaborating to conduct a study based on the premise that growth rates of young-of-the-year fishes vary as a function of habitat quality. The project involves identifying critical habitats (e.g., eelgrass beds, mudflats, and salt marshes) in three northeastern estuarine systems having similar habitats (Great Bay--Little Egg Harbor and the Hudson-Raritan systems in New Jersey and the Connecticut coast of Long Island Sound) and assessing their functional value as nursery areas for winter flounder and tautog. Habitat use patterns for young-of the-year fishes and movements and growth of recently settled fishes in the three estuarine systems are being compared in an effort to define differences in habitat quality that could be related to recruitment processes.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

This project provides an essential first step toward developing management strategies for fisheries and related habitats. By determining growth of a species at the same life stage across habitat types among estuaries that are geographically close, a comparison of the functional value of those habitats will be possible and appropriate for incorporation into a spatially oriented ecosystem model. Determining movements among these habitats will allow linkages between the primary habitats to be defined in concert with an analysis of trophic relationships. Quantification of the relative importance of specific habitats will provide a valuable tool toward making decisions for managing, conserving, and restoring coastal habitats critical to the support of living marine resources. In addition, the techniques developed as part of this project may provide excellent biomonitoring tools for tracking the health of the estuaries.

ESTUARINE HABITAT PROGRAM
FUNCTIONAL VALUE
EAST AND WEST COAST SALT MARSH COMPARISON

THE ISSUE:

Research has emphasized east and Gulf coast salt marshes with far less emphasis being placed on salt marsh systems of the west coast. It has been assumed that observations on plant development, nutrient cycling, faunal development, and food webs are readily transferable from coast to coast. However, there are climatic and geomorphological differences between estuarine wetlands on the two coasts which lead to differences in species composition and diversity, tidal zonation of vascular plants, and potentially important differences in production and trophic food webs.

THE APPROACH:

The overall goal of this project, initiated in 1994, is to compare salt marshes on the east and west coasts in terms of primary producers, infauna, and trophic linkages. Academic and NOAA researchers from North Carolina and California are collaborating to address the habitat and trophic linkages within salt marshes on both geographic and developmental scales. Three priority areas are being addressed: the role of estuarine habitats in supporting living marine resources; the linkage between habitats (salt marsh and tidal mudflat); and comparisons of salt marsh and mudflat function with respect to geographic location and developmental stage (i.e., natural vs. transplanted or invasive species marshes).

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

The data will be utilized to develop a conceptual model describing the effects of interactions among *Spartina* spp, irradiance, tidal regime, and sediment physico-chemical properties on salt marsh primary production and secondary producers. Additionally, the project will provide data that can be used to determine how coastal and estuarine habitats function to support living marine resources, including development of methods for habitat restoration and creation, and incorporation of functional information into quantitative and qualitative models for use by habitat managers in protecting, conserving, and restoring critical habitats.

ESTUARINE HABITAT PROGRAM
LANDSCAPE ECOLOGY
NORTH CAROLINA SALT MARSH-SEAGRASS LINKAGES

THE ISSUE:

Intertidal salt marshes and subtidal seagrasses, mud flats, and sand flats come together in a mosaic of patterns to create heterogeneous estuarine landscapes. Many fishery species and other living marine resources are highly mobile and utilize each of these habitats for foraging and/or predator avoidance either on a daily basis or during parts of their life cycles. Linkages between the landscape components have not been well studied, but are potentially important in the transfer of energy through the estuarine food web and the resultant production of living resources. Understanding the role of linkages among the component habitats on the growth and survival of prey organisms and foraging of predators is essential as we strive to manage entire ecosystems and not just individual habitats.

THE APPROACH:

The overall goal of this project is to assess the advantage to fishes and crabs of being able to utilize both salt marsh and seagrass habitats, rather than being confined to one or the other. Researchers in North Carolina are examining trophic linkages and multi-species predator-prey interactions between salt marshes and adjacent subtidal habitats using field and laboratory experiments. Whether or not growth of forage fish and/or juvenile blue crabs differ between marshes with and without adjacent submerged aquatic vegetation (SAV) will be tested. Field sampling will also determine if utilization of marshes by forage fish and blue crabs differs between marshes with and without SAV and/or if predators alter their time spent foraging between these two landscape types. Mesocosm studies will be used to examine the influence salt marshes with and those without adjacent SAV have on predator-prey interactions among several estuarine species and multiple trophic levels.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Results will aid directly in making predictions concerning the relative contribution within existing estuarine landscapes to living marine resources and fishery production. Findings will also aid resource managers in making decisions based on habitat functionality concerning site selection for restoration and/or preservation projects to maximize production of living marine resources.

ESTUARINE HABITAT PROGRAM
LANDSCAPE ECOLOGY
HABITAT FUNCTION AND INTERACTION
DUE TO LAND-BASED NUTRIENT LOADING

THE ISSUE:

The area and configuration of subtidal habitats of bays of the Cape Cod region have changed over the past four decades from eelgrass meadows to a seaweed canopy. This shift is linked to increased nutrient loadings from watersheds subject to urban development around the margins of the estuaries. There is evidence that salt marshes can significantly intercept land-derived nitrate before it reaches the estuarine water column by converting it to N_2 through the process of denitrification (considered a "bottom-up"mechanism), and therefore act as a control. However, "top-down" mechanisms such as grazing pressure also exert control on abundance of vegetation. It is important to learn the relative importance of each of these mechanisms.

THE APPROACH:

The overall goal of this project is to develop an understanding of how fringing salt marshes modify the effects of land-derived nutrients on adjacent seagrass beds. Researchers in Massachusetts are conducting an effort to document the couplings among adjoining habitat parcels and are examining how these couplings affect the assemblages of animals, plants, and seaweeds that live in the systems. The study is considering natural and anthropogenic inputs of nitrogen from land, focusing on the transformation of nitrogen during passage through salt marsh parcels, and investigating how the aquatic ecosystem responds to the transformed inputs. The extent and location of adjoining coastal habitats is being determined by *in situ* mapping and data processing by a geographic information system. This work expands and takes advantage of the Waquoit Bay Land Margin Ecosystems Research project.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

The program will produce a detailed map of habitats in Waquoit Bay, insights as to how adjoining habitat parcels interact with each other, a description of benthic fauna in different habitats and in water bodies subject to different nitrate loading rates, information as to how denitrification rates change as nitrate loading increases, and how loading rate changes water quality. The data will aid in the formulation of models that incorporate function and spatial arrangement of habitat mosaics of different habitats.

ESTUARINE HABITAT PROGRAM
LANDSCAPE ECOLOGY
COLUMBIA RIVER ESTUARY AND WILLAPA BAY

THE ISSUE:

Coastal managers usually must consider the ecological and economic functions of coastal wetlands as comparable over broad geographic regimes despite often-substantive regional differences in factors that influence wetland processes. One consequence of this lack of regional specificity is that wetlands are often managed as static systems when, in fact, they are dynamic. This is particularly true of the coastal estuaries of the Pacific Northwest, which are different from marshes in other regions of the United States. Application of many of the existing conceptual models about coastal wetland function, which have largely been based on Gulf of Mexico marshes, may be inappropriate because they originate from studies in less dynamic systems. Understanding how these dynamic factors influence natural successional processes in Pacific Northwest estuaries is critical to revising these models and their contribution to estuarine management.

THE APPROACH:

The overall goal of this project, initiated in 1994, is to assess the effects of increasing *Spartina* growth on mudflat ecosystems and the estuarine system. Researchers in the states of Washington and Louisiana, and from NOAA and USGS, are evaluating sedimentation processes that influence marsh expansion and erosion on a variety of time scales (historical and recent), and the ecological implications to estuarine consumers of changing regimes of marsh and unvegetated (mudflat) habitats in the Pacific Northwest region. The research focuses on two estuarine emergent marsh-mudflat systems, the Columbia River estuary and Willapa Bay.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Comparisons of the processes of expansion at work in emergent marshes and of the relative ecological role of marsh vs. mudflat habitats in the two estuaries will provide information of direct importance to estuarine resource management issues in the region. This work will also provide a detailed understanding of habitat function in an area where the Coastal Change Analysis Program (C-CAP) is already conducting large-scale land cover mapping.

ESTUARINE HABITAT PROGRAM
LANDSCAPE ECOLOGY
SPATIAL EVALUATION OF SEAGRASS ECOSYSTEMS

THE ISSUE:

Information on the functional role of living marine resources has been based largely on research conducted at less than a one square meter scale extrapolated up to two meters and beyond. Few studies examine directly the consequences of habitat heterogeneity across spatial scales. Although our understanding of plant-animal relationships over small scales has increased, our ability to apply findings is limited. This is especially true at scales at which management decisions are made: from ten to 1000 meters for regulatory actions and possibly up to an entire estuarine basin for regional planning. Landscape ecology may provide a vehicle with which to overcome scale-dependent limitations. More specifically, it may provide us with conceptual and analytical tools to evaluate seagrass ecosystems in a spatial as well as temporal context.

THE APPROACH:

The goal of this 1994 initiative, which is based on past research funded by COP, is to assess seagrass bed plant and animal communities on a variety of spatial scales. Researchers from Florida and NOAA are proceeding to determine whether landscape patterns of seagrass ecosystems can represent functional attributes when examined across multiple spatial scales. To this effect, the project will address whether seagrass bed functions derived at the one square meter scale can be resolved by coarser grain representations of the landscape.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

The findings will be directly applied to habitat restoration and conservation. By employing simulation and statistical analyses, how physical energy regimes and accompanying landscape patterns influence living marine resource utilization can be shown, and thus the scale of impacts to seagrass ecosystems can be better defined and defended in management strategies.

ESTUARINE HABITAT PROGRAM
LANDSCAPE ECOLOGY
SALT MARSH GEOMORPHOLOGY

THE ISSUE:

The importance of morphology (form and structure) to the function of ecosystems has recently been realized, opening the new field of landscape ecology. This new field has applications not only to natural landscapes but also to developed landscapes. The concept that salt marsh function may be controlled by marsh morphology has been the subject of research along the Atlantic coast of the United States. However, a weakness in the pursuit of supporting evidence for this concept has been the lack of a suitable means of quantifying differences among marsh morphologies.

THE APPROACH:

The overall goal of this project, initiated in 1994, is to assess the relationship among various descriptors of salt marsh morphology and functional characteristics such as nutrient and material flux and fisheries. Researchers from South Carolina and NOAA will establish a series of objective, ecologically relevant spatial indices of marsh geomorphology and vegetation patterns, and broadly apply them to disparate salt marsh systems in an attempt to explain overall habitat quality and important functions. Using remotely sensed imagery, a geographic information system, and image analysis, spatial indices will be determined and combined with biological, hydrological, and other information from a series of salt marsh estuaries to quantify habitat linkages. Using multivariate statistical methods, the relationship between the indices developed and the structural (habitat quality) and functional (nutrient flux) natures of the ecosystem will be explored.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

A predictive model of habitat-specific and system-wide nutrient flux will be established, based upon the various indices and historical flux data from the series of salt marshes examined under the project. This landscape analysis approach can be used to monitor regional salt marsh wetland status, predict impact of changes in salt marsh systems to coastal ocean marine resources, provide information that will enhance the effectiveness of marsh mitigation and restoration practices, and investigate factors influencing ecosystem function.

ESTUARINE HABITAT PROGRAM
INTEGRATIVE MODELING
COASTAL LANDSCAPE DYNAMICS OF MARYLAND'S EASTERN SHORE

THE ISSUE:

Although some of the environmental damage suffered by the Chesapeake Bay area has been reversed, the future threat posed by land subsidence and rising sea-level in the next century to the Bay's biological and physical systems is largely unknown. Many tidal marshes around the bay are presently losing ground to rising sea levels and land subsidence. Rates of erosion in the Blackwater River system on Maryland's Eastern Shore are so high that it appears to be much less desirable fish habitat. Since this part of the Chesapeake Bay area is the center of marsh loss, it will be the first test case for development and testing of management scenarios.

THE APPROACH:

The overall goal of this project is to develop a spatial modeling approach that will enable functional models to be combined with geographic information system (GIS) data to predict landscape dynamics and the resultant effects on living marine resources. A specific objective is to apply this approach to the Blackwater River watershed. Researchers from Maryland and NOAA are assessing historical changes in the watershed from 1903 to the present by creating a GIS database of these changes, and assembling the database necessary for creation of a process-based, spatially explicit ecological model incorporating forcing functions at seaward and landward boundaries to explain these historical changes. The project is being integrated with the EPA-funded Multiscale Experimental Ecosystem Research Center, and will provide the macroscale application missing from that effort.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Coordinated with Coastal Change Analysis Program (C-CAP) investigators, the project will explore ways that the models can be combined with remote sensing and GIS data of habitat change in a unique package developed for broad application. Digital overlays of marsh loss in the Blackwater system from 1903 to 1990 will be prepared using U.S. Geodetic Survey maps and recent color aerial photography to facilitate comparisons with recent rate of change maps prepared for C-CAP.

ESTUARINE HABITAT PROGRAM
INTEGRATIVE MODELING
EELGRASS IN GREAT BAY, NH

THE ISSUE:

Seagrass beds are critical coastal habitats that currently are being degraded and lost due to pollution and disease. Work supported by the COP has led to important advances in our understanding of the mechanisms underlying the control of eelgrass habitat distribution and population health by disease and nutrient loading. It is now appropriate to incorporate this knowledge into quantitative models, address the most important remaining gaps in our knowledge through continued experiments. A methodology will be developed to create a spatially based habitat- function model that can assess habitat change within known error and ultimately predict losses in living marine resources based on our knowledge of the important functions and processes that regulate vegetated habitats.

THE APPROACH:

The overall goal of this project is to develop a spatial simulation model that predicts changes in eelgrass distribution in an estuarine system. Researchers from New Hampshire and NOAA are building on previously funded COP research, creating a model based on the factors and processes that regulate eelgrass habitat persistence and loss through the simulation of previously conducted mesocosm experiments. The eelgrass habitat model is being formulated as a sector for the multi-habitat Generic Ecosystem Model (GEM) developed at the Chesapeake Biological Laboratory, and will become part of a larger national effort to develop an easily applicable multi-user coastal ecosystem model. Additionally, the eelgrass-GEM will form the basic unit of a spatial model for a case study and validation to simulate the eelgrass distribution in Great Bay, New Hampshire. A geographic information system (GIS) for Great Bay will tie field verification data and experimental results to the operation of the model.

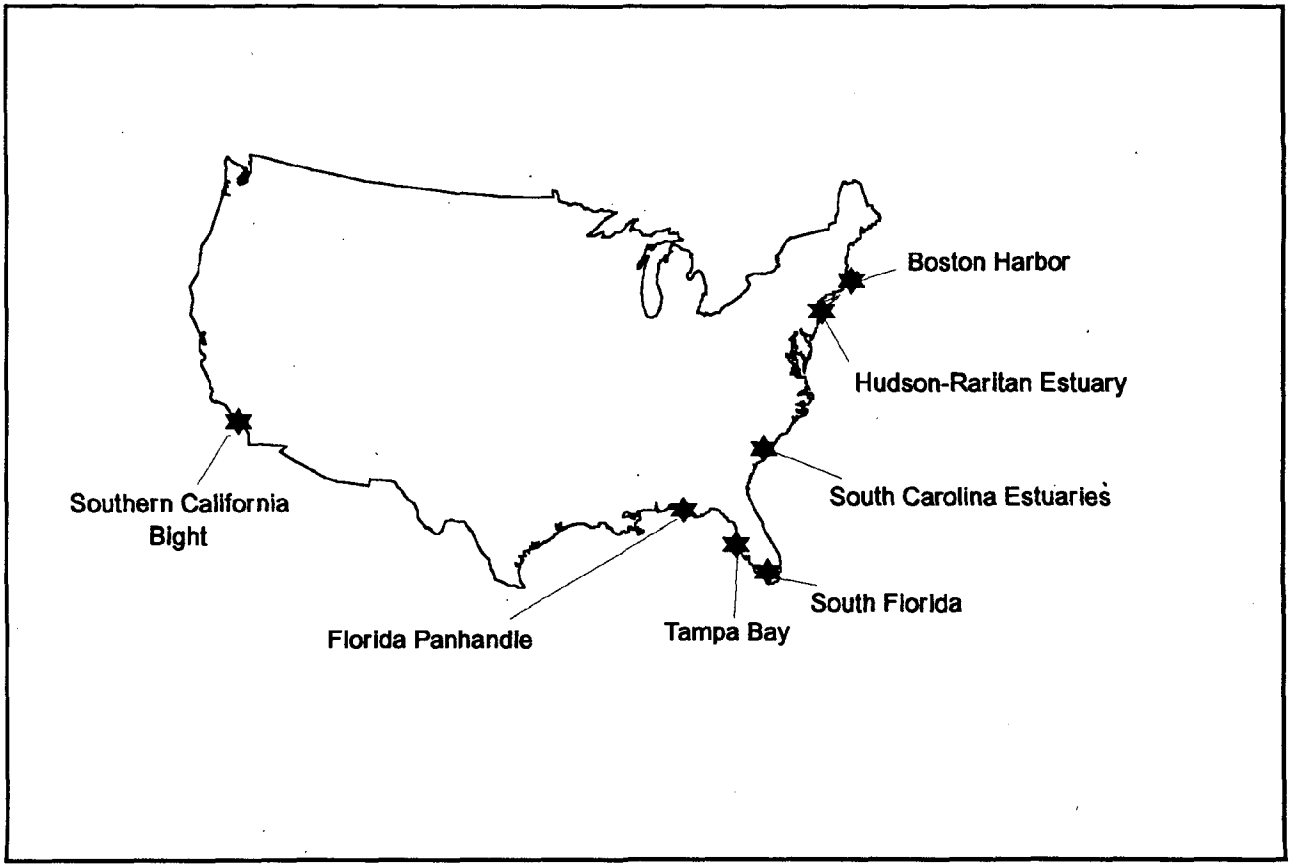
ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

The primary product will be a user-friendly spatial simulation model for Great Bay that can be adapted to other estuarine systems and accessed by managers and scientists to predict the effects of human activities and natural phenomena on the survival of eelgrass habitats. The model will be utilized by the Great Bay Estuarine Research Reserve to examine how the effects of development pressure, increased nutrient loading, and other human activities will impact eelgrass and the resources supported by this habitat.

NOAA COASTAL OCEAN PROGRAM

Toxic Chemical Contaminants Program

Toxic Contaminant Bioeffects Surveys



TOXIC CHEMICAL CONTAMINANTS PROGRAM

THE ISSUE:

The technologically advanced society of the United States releases many different potentially toxic substances to the environment, many of which find their way into coastal and estuarine waters. Little is known about the ultimate fates of these contaminants and their effects on living resources and other organisms. Toxic contaminants may cause undesirable biological effects to organisms in the environment. Further, toxic contaminants may also accumulate in living marine resources at levels that pose a threat to human consumers of these resources. The resource managers who make vital decisions on regulation and protection of our coastal environments need accurate and reliable information on toxics, their sources, loading rates, and fate and effects in the environment.

THE APPROACH:

In 1991, the Toxic Chemical Contaminants Program was created under the NOAA Coastal Ocean Program (COP) to develop the information needed by decision makers concerning the effects of contaminants on coastal resources. It is designed to augment, integrate, and expand the efforts of the National Status and Trends Program in NOAA's National Ocean Service and National Marine Fisheries Service. Three major activities are being funded: 1) a national survey of toxic contaminant bioeffects; 2) bioeffects indicator development; and 3) bioeffects and bioaccumulation research. The COP hopes to assess the status and trends of environmental quality in relation to levels and effects of toxic contamination in U.S. marine, estuarine, and Great Lakes environments, as well as develop a predictive capability for effects of toxic contamination on marine resources and human uses of these resources.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Major progress has been achieved in all three elements. The first element is directed at a cumulative national assessment of the extent and magnitude of environmental degradation related to contamination by toxic chemicals. Progress to date in these bioeffects surveys is the near-completion of peer-reviewed summary reports from Long Island Sound, Tampa Bay, Hudson-Raritan Estuary, and Boston Harbor. FY94 activity will see the completion of these status reports, the continuation of surveys in the Southern California Bight, coastal South Carolina, and northwest Florida bays, and an initiation of a survey in South Florida. The development of new and improved methods for quantifying bioeffects of toxics is the major objective of the second element in this program. The studies in this element have established dose-response relationships for three bioindicators. This element has developed assays for each of the three major components of the immune system in flatfish and a database on the magnitude and extent of exposure of mussels and oysters to chemical contaminants. The bioeffects research to establish links between contaminant exposure and significant effects, such as population declines and community alterations, is still underway.

TOXIC CHEMICAL CONTAMINANTS PROGRAM
TOXIC CONTAMINANT BIOEFFECTS SURVEYS

THE ISSUE:

The technologically advanced society of the United States releases many different potentially toxic substances to the environment, and much of this material finds its way into coastal and estuarine waters. We still have much to learn about the ultimate fates of these contaminants and their effects on living resources and other organisms. Toxic contaminants may cause undesirable biological effects to organisms in the environment. Further, toxic contaminants may also accumulate in living marine resources at levels that pose a threat to the human consumers of these resources. The resource managers who make vital decisions on regulation and protection of our coastal environments need accurate and reliable information on toxics, their sources, loading rates, and fate and effects in the environment.

THE APPROACH:

A series of systematic multi-year field surveys has been initiated to estimate magnitude and extent of ecological degradation in coastal areas as a result of exposure to anthropogenic toxic materials. Biological indicators are being monitored in areas identified by the NOAA's National Status and Trends Program to have elevated levels of toxics. The results are being used to develop local and national assessments of toxic impacts on coastal ocean resources. These surveys also provide a means to field test new bioeffects indicators. The bioeffects surveys include sampling and analyses to determine such properties as indicators of contaminant exposure and contamination-induced stress, reproductive impairment and genetic damage in important fish species, sediment toxicity to sensitive organisms, and community structure of bottom fauna related to contaminant levels.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Field-work in Tampa Bay, Hudson-Raritan Estuary, and Boston Harbor was largely completed in FY93, while surveys began in Southern California in FY92 and will continue through FY94. Studies were initiated during FY93 in coastal South Carolina and in the bays of the Florida panhandle and will continue through FY95. A new study began in FY94 in the coastal systems of South Florida, encompassing Biscayne Bay to the east and Florida Bay to the west. It is anticipated that several more sites will be chosen for study, and that at the completion of such investigations, a more detailed national assessment of the extent and magnitude of contaminant-related biological effects in the nation's coastal waters will be prepared.

TOXIC CHEMICAL CONTAMINANTS PROGRAM
TAMPA BAY BIOEFFECTS SURVEY

THE ISSUE:

Contaminant concentrations in parts of Tampa Bay are relatively high. Especially high are concentrations of lead, mercury, arsenic, zinc, and chlorinated pesticides, including DDT and chlordane. These contaminants may be toxic to living natural resources in the Bay and therefore warrant an intensive research effort to determine their distribution, concentration, and effects. Very little quantified information exists on adverse biological effects attributed to toxicants in the Bay. A variety of biological resources in the Tampa Bay region have undergone gradual declines in abundance or commercial landings.

THE APPROACH:

In 1990, the NOAA Coastal Ocean Program (COP) initiated multi-disciplinary surveys measuring biomarkers of contaminant effects in three species of fishes (hardhead catfish, mummichogs, and red drum) and in the blue crab. In addition, indicators of oyster health throughout the Bay and sediment chemistry and toxicity were measured. The COP is cooperating with the Florida Department of Environmental Protection (DEP) to determine:

- the severity and geographic extent of problematic contamination of Tampa Bay by toxicants;
- the severity and geographic extent of adverse biological effects associated with toxicants in Tampa Bay; and
- how concentrations of potentially toxic substances in Tampa Bay have changed over time.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Studies completed include: three years of assessment of biomarkers in fishes and crabs; two years of study of indicators of oyster health; and a survey of sediment toxicity and chemistry at 30 sites throughout the Bay. Through the cooperation of the DEP, chemical analyses of sediments have been carried out by the Skidaway Oceanographic Institute of the University of Georgia. The biomarkers study in oysters was completed in 1993, as were the analyses of sediment and tissue samples collected earlier in the survey. The COP is placing major emphasis on the synthesis of the results of these efforts and the preparation of summary reports so that the information may be transferred to resource managers and other interested parties in the region in 1994.

TOXIC CHEMICAL CONTAMINANTS PROGRAM
WESTERN FLORIDA PANHANDLE BIOEFFECTS SURVEY

THE ISSUE:

Oyster samples collected from the area extending from Appalachicola Bay to Pensacola Bay, including St. Andrew Bay, Panama City, and Choctawatchee Bay, have contained very high concentrations of pesticides, aromatic hydrocarbons, and many trace metals. The concentrations of some chemicals have been the highest observed nationwide in some years. With reference to contamination by toxicants, the State of Florida ranks this area as a very high priority.

THE APPROACH:

The NOAA Coastal Ocean Program has initiated a multi-disciplinary series of bioeffects surveys in the bays of the western Florida panhandle. Surveys of bioeffects are being carried out for demersal fish, oysters, and sediments. The data from the demersal fishes are expected to demonstrate the occurrence of bioeffects in relatively mobile species that integrate the effects of contaminants over large areas. The data from oysters will provide information from a sessile feeder, and the data from the sediment toxicity tests will provide the best resolution on the spatial extent of toxic chemical bioeffects.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Surveys in the western Florida panhandle study area began in 1993. Sediment toxicity samples have been collected from about 40 sites in the Pensacola Bay area, and about 31 sites in the St. Andrew Bay area. The data will be evaluated to identify spatial patterns in toxicity, the severity of toxicity, and the relationships between toxicity and chemical concentrations. An oyster bioeffects survey has been initiated in FY94. Also in FY94, bioeffects studies on fishes are being carried out in representative sites in East Bay, Escambia Bay, Pensacola Bay, Bayou Grande, and Bayou Chico. Length, weight, gender, condition indices, and general condition of each fish is being recorded. Liver, kidney, and bile samples are being taken for analysis as well.

TOXIC CHEMICAL CONTAMINANTS PROGRAM
HUDSON-RARITAN ESTUARY BIOEFFECTS SURVEY

THE ISSUE:

Data from NOAA's National Status and Trends (NS&T) Program have consistently shown that sites in the Hudson River/Raritan Bay Estuary are relatively highly contaminated with a variety of chemicals. For a suite of toxic metals and several categories of toxic organic compounds, both in sediments and bivalve mollusks, the Hudson-Raritan Estuary sites consistently appear in the top 25th percentile of all NS&T sites analyzed, suggesting that the potential for contaminant associated biological effects is very high.

THE APPROACH:

The NOAA Coastal Ocean Program has initiated a series of multi-disciplinary surveys at various sites in the estuary. The surveys hope to:

- o determine contaminant effects on reproductive processes in winter flounder;
- o survey distributions of sediment-associated toxicity, relative to gradients of contamination concentrations;
- o determine potential occurrence of toxicity related to presence of free ionic metals in the water column; and
- o examine composition of benthic infaunal communities in relation to distribution of sediment toxicity and contamination.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Work completed from 1990-93 includes measurements of a number of bioindicators of reproductive impairment in winter flounder, acute sediment toxicity to several indicator organisms, contaminant trends in sediment cores, and ambient water toxicity of copper and zinc. Also included were a major sediment toxicity survey and a complementary study to investigate the occurrence of sediments contaminated with sublethal levels of toxics. Chemical analyses and toxicity studies of sediment samples were completed during FY93, and a major effort is being placed on the synthesis of results from the efforts of all previous studies. Chemical analyses and toxicity studies of sediment samples collected early in 1993 have been completed, and summary reports are being prepared in 1994 in order to disseminate this information to resource managers and other interested parties in the Hudson-Raritan region.

TOXIC CHEMICAL CONTAMINANTS PROGRAM
BOSTON HARBOR BIOEFFECTS SURVEY

THE ISSUE:

Boston Harbor is located in a highly urbanized area and is thus subject to accumulation of many contaminants. The Inner Harbor, Northwest Harbor, Central Harbor, and Southeast Harbor all contain high levels of toxic contaminants. The spatial patterns of contaminants and severity in toxicity with the attendant biological effects are not well known and are thus in need of investigation.

THE APPROACH:

The NOAA Coastal Ocean Program has carried out a series of multi-disciplinary surveys measuring bioeffects in winter flounder, reproductive impairment in bivalves, and sediment toxicity. Data from these surveys are being evaluated along with data from several dredging and construction projects in the Harbor in order to link severity and location of toxicity to biological response.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Bioeffects studies have been carried out in Boston Harbor to survey the incidence of histopathological disorders in winter flounder and better understand the biochemistry of possible reproductive impairment in resident mussels and soft-shell clams. Studies to scope the growth of these shellfish species have been completed as well. To complete the assessment of Boston Harbor, an intensive survey of sediment toxicity was carried out in which tests were performed with invertebrate organisms. Sediment samples were taken from the Inner Harbor, Northwest Harbor, Central Harbor, and Southeast Harbor. Analyses of these samples are still underway. Following the completion of the chemical analyses of the samples from the 1993 survey, the data will be analyzed and a major effort will be placed on the synthesis of the results along with those of previous studies.

TOXIC CHEMICAL CONTAMINANTS PROGRAM
SOUTHERN CALIFORNIA BIOEFFECTS SURVEY

THE ISSUE:

Numerous benthic community and sediment studies have been conducted in coastal southern California, especially in Santa Monica Bay and on the continental shelf adjacent to the large municipal treatment plants in Los Angeles, Orange County, and San Diego. These studies have demonstrated significant biological responses to contaminants. While these areas have received the most attention thus far, very little information exists for other areas in southern California. Many of these lagoons and bays receive runoff from large upland areas, and inputs of toxicants from industry, residential areas, and boats. More information is needed to estimate the magnitude and extent of effects in southern California in order to be able to make appropriate decisions on how to remediate the toxicant effects and initiate clean-up actions.

THE APPROACH:

The NOAA Coastal Ocean Program (COP), in cooperation with the California Water Resources Control Board, has initiated a series of systematic multi-year field surveys to study bioindicators of contaminant exposure and effects in fishes and on the distribution of sediment contamination and toxicity. The research hopes to determine:

- the presence or absence of adverse biological effects in selected onshore and coastal areas of Southern California;
- the relative degree or severity of toxicant effects;
- the spatial distribution of toxicant-associated effects in Southern California;
- the relationship between toxicants and measures of effects in Southern California; and
- the relative performance of a battery of biomarkers.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Sediment chemistry and toxicity bioassays have been performed at 29 sites distributed between Los Angeles and Huntington Harbor. These observations have also been conducted at 32 sites in San Diego Bay and Mission Bay. The relationship between the spatial extent of sediment toxicity and contaminant bioeffects in fishes are being explored in these surveys. In 1994, a smaller number of sites is being evaluated in other coastal embayments in the study area. Pilot studies have been conducted to evaluate biomarkers of contaminant stress in bivalve mollusks. The COP is also supporting the preparation of summary reports for use by resource managers and other interested parties in the region in 1994 as well as supporting the initiation of sampling for the third year.

TOXIC CHEMICAL CONTAMINANTS PROGRAM
SOUTH CAROLINA ESTUARIES BIOEFFECTS SURVEY

THE ISSUE:

Several estuaries along the South Carolina/northern Georgia coast are known to be relatively highly contaminated and under intense pressure from urbanization. Oysters sampled as part of the National Status & Trend's Mussel Watch Program show relatively high concentrations of aromatic hydrocarbons, detectable levels of several pesticides, and very high concentrations of arsenic, silver, and other trace metals. These contaminants can be very harmful if consumed by humans. Therefore, it is necessary to understand what the specific effects of urbanization on the coastal estuaries are in order to make appropriate decisions for the protection from and mitigation of harmful effects on marine life and human health.

THE APPROACH:

The NOAA Coastal Ocean Program (COP) is initiating a series of surveys consisting of sediment toxicity testing, and oyster and fish bioeffects determinations. A cooperative effort between the University of South Carolina and the Charleston Laboratory of the National Marine Fisheries Service entitled "Urbanization and Southeastern Estuarine Systems" is underway. This effort focuses on the effects of urbanization on estuaries along the South Carolina/northern Georgia coast. The Jacksonville and Charleston districts of the U.S. Army Corps of Engineers have also begun a series of surveys of sediment toxicity in the Federal channels of the estuaries along the South Carolina and northern Georgia coasts with which the toxics effort is being coordinated. The potential to cooperate with these programs affords the COP an excellent opportunity to provide very useful information for this study area. The following estuaries will be surveyed over a three-year period: Winyah Bay, Charleston Harbor/Cooper River estuary/Ashley River estuary, Savannah River estuary, and (in Georgia) St. Simons Sound/Brunswick Harbor.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

In FY93, sediment samples were taken from about 30 sites in the Charleston Harbor area, including the lower Cooper, Ashley, and Wando Rivers, Charleston Harbor, and the Harbor entrance, while demersal fishes were taken from six sites in the same area. In 1994, an oyster bioeffects survey is being conducted to measure their size and condition, histological evaluations of their fecundity and reproductive condition, incidence of histopathological disorders, incidence of cytogenetic/cytologic disorders, incidence of DNA anomalies, and impairment of immunological competence. The sediment toxicity survey collected samples that are being tested and evaluated to identify spatial patterns of toxicity, the severity of toxicity, and the relationships between toxicity and chemical concentrations. Samples of liver and kidney tissues, bile, and other selected tissues are being examined for indication of adverse contaminant responses.

TOXIC CHEMICAL CONTAMINANTS PROGRAM
SOUTH FLORIDA BIOEFFECTS SURVEY

THE ISSUE:

Biscayne Bay is known to have extremely elevated concentrations of toxicants, including pesticides and trace metals in water, sediments, and biota. Fish with high incidences of pathological disorders have been observed. In Biscayne and Florida Bays, major environmental quality problems have been identified, including contaminants and concurrent problems of habitat disruption, nutrient additions from fertilized agricultural lands, runoff and diversion of surface waters, and fisheries exploitation. The South Florida area has, therefore, been identified by the Florida Department of Environmental Protection (DEP) as a high priority area for potential toxicity.

THE APPROACH:

The NOAA Coastal Ocean Program (COP) has initiated a series of multi-disciplinary surveys consisting of sediment toxicity testing and fish/invertebrate bioeffects studies. The COP is cooperating with the DEP and regional participants (South Florida Water Management District and Dade County Environmental Resource Management) in an initial survey of sediment toxicity by assisting in the planning and survey design, participating in the sample collection, data analysis, and reporting. A preliminary reconnaissance survey of fish/invertebrate biomarkers is being conducted in Biscayne Bay during FY94 to ascertain the extent to which contaminant-related bioeffects are evident in resident organisms of the Bay.

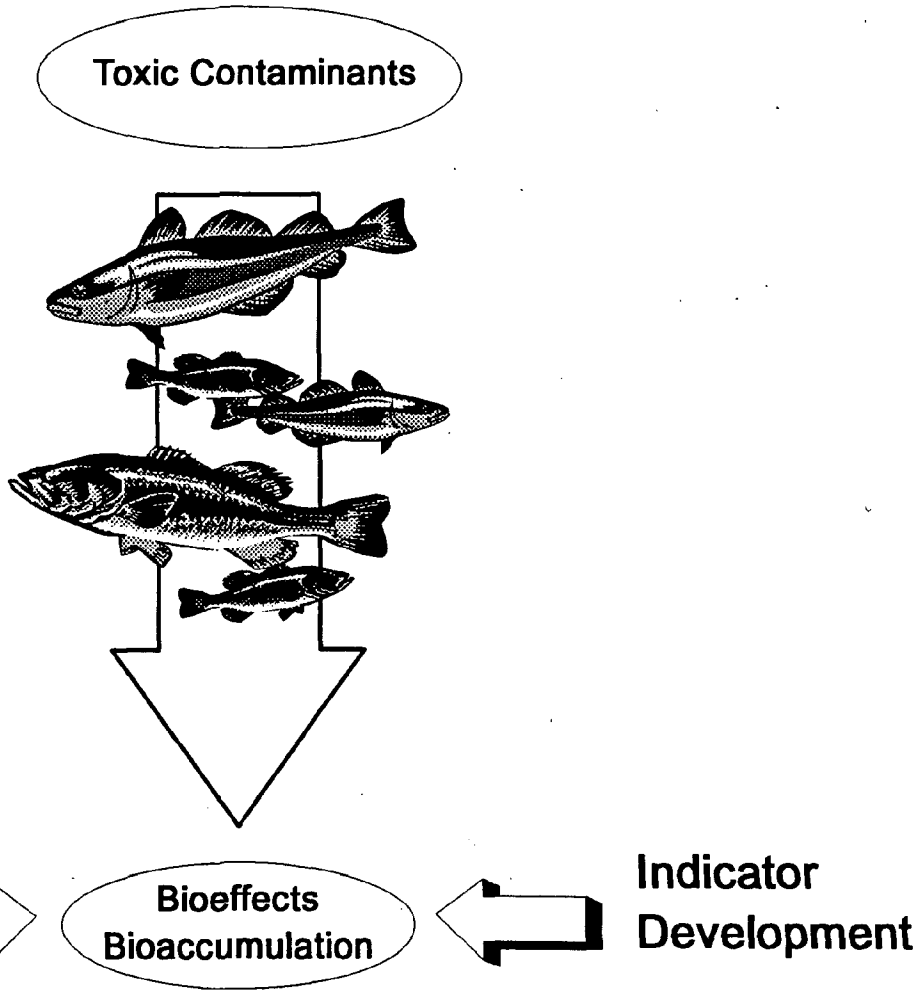
ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

These first year studies will be supplemented in FY95-96 with a follow-up (more intensive) sediment toxicity survey in Biscayne Bay, a preliminary sediment toxicity survey in Florida Bay, and chemical analyses of selected biomarkers in Biscayne and Florida Bays. Detailed planning of the second and third year studies will depend on results of the first year's efforts. It is anticipated that the preliminary surveys will assist in the interpretation and assessment of cumulative effects in this region and will form a much improved basis for design of future studies. Most importantly, efforts in this area will contribute to the interagency effort to restore environmental quality to South Florida.

NOAA COASTAL OCEAN PROGRAM

Toxic Chemical Contaminants Program

Bioeffects Research



TOXIC CHEMICAL CONTAMINANTS
BIOEFFECTS INDICATOR DEVELOPMENT

THE ISSUE:

Current monitoring efforts lack sensitive indicators of the biological impacts of toxics and do not provide the information needed to assess and predict the ecological impacts of toxic contamination.

THE APPROACH:

This project aims to improve our understanding of the underlying mechanisms that govern contaminant-induced changes in marine organisms. Bioindicators are indices that measure these changes in marine organisms, including measurements of contaminant exposure and responses at the biochemical, physiological, and organismal levels. Bioindicators allow monitoring of indigenous organisms, improved understanding of cause and effect, and development of early-warning signals of effects. Such indicators would expand the utility of current NOAA and EPA monitoring programs.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

In FY91, NOAA began testing recently developed bioindicators in target fish species. These indicators include: an enzyme that increases when exposed to low levels of a broad spectrum of chemical contaminants, providing a sensitive response to exposure; genetic damage in liver that may be important in linking contaminant exposure to cancer and other damage to living marine resources; and chemical levels in bile, indicative of exposure to polynuclear aromatic hydrocarbons which have been linked to liver cancer and impaired reproductive processes in fishes. A major focus has been the systematic validation and comparison of these three indicators in target fish species used in NOAA's National Status and Trends Program. Laboratories in three regions, Northeast (winter flounder), Northwest (starry flounder and English sole), and Southwest (white croaker), were supported to facilitate these analyses for FY92.

New bioindicators developed and evaluated in FY91-92 included effects on fish immune systems and biochemical disorders. In FY93, a draft final report on validation of recently developed bioindicators was generated, the methodology development and initial validation of candidate bioindicators were completed, and a study plan for completing validation of promising candidate bioindicators in fish was developed. In FY94, activity is continuing to develop and test bioindicators in fishes and in invertebrates.

TOXIC CHEMICAL CONTAMINANTS
BIOEFFECTS AND BIOACCUMULATION RESEARCH

THE ISSUE:

Although populations of marine fishes and invertebrates have declined significantly in many urbanized coastal and estuarine areas due to chemical pollution, habitat loss and degradation, and harvesting practices, it is not known to what extent chemical contamination contributes to this problem. Moreover, the rates of uptake of toxic substances by marine organisms are known to be influenced by physical, chemical, and biological factors, yet little is known about the mechanisms and impacts of these factors.

THE APPROACH:

Research on the bioaccumulation and bioeffects of toxic contaminants is a step toward a better understanding of the fate and effects of toxics in the marine environment. The ultimate goal of the Bioeffects Research Project is to determine contaminant-induced effects at the population level in marine fishes and invertebrates. Initially, however, the link between contaminant exposure and its impacts must be demonstrated in individuals. Research is focusing on contaminant-induced effects on the survival, growth, and fecundity of individuals having implications at the population level. Bioaccumulation research focuses on a particular aspect of contaminant behavior: the biogeochemical mechanisms controlling the bioaccumulation of toxic substances in fishes and invertebrates.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

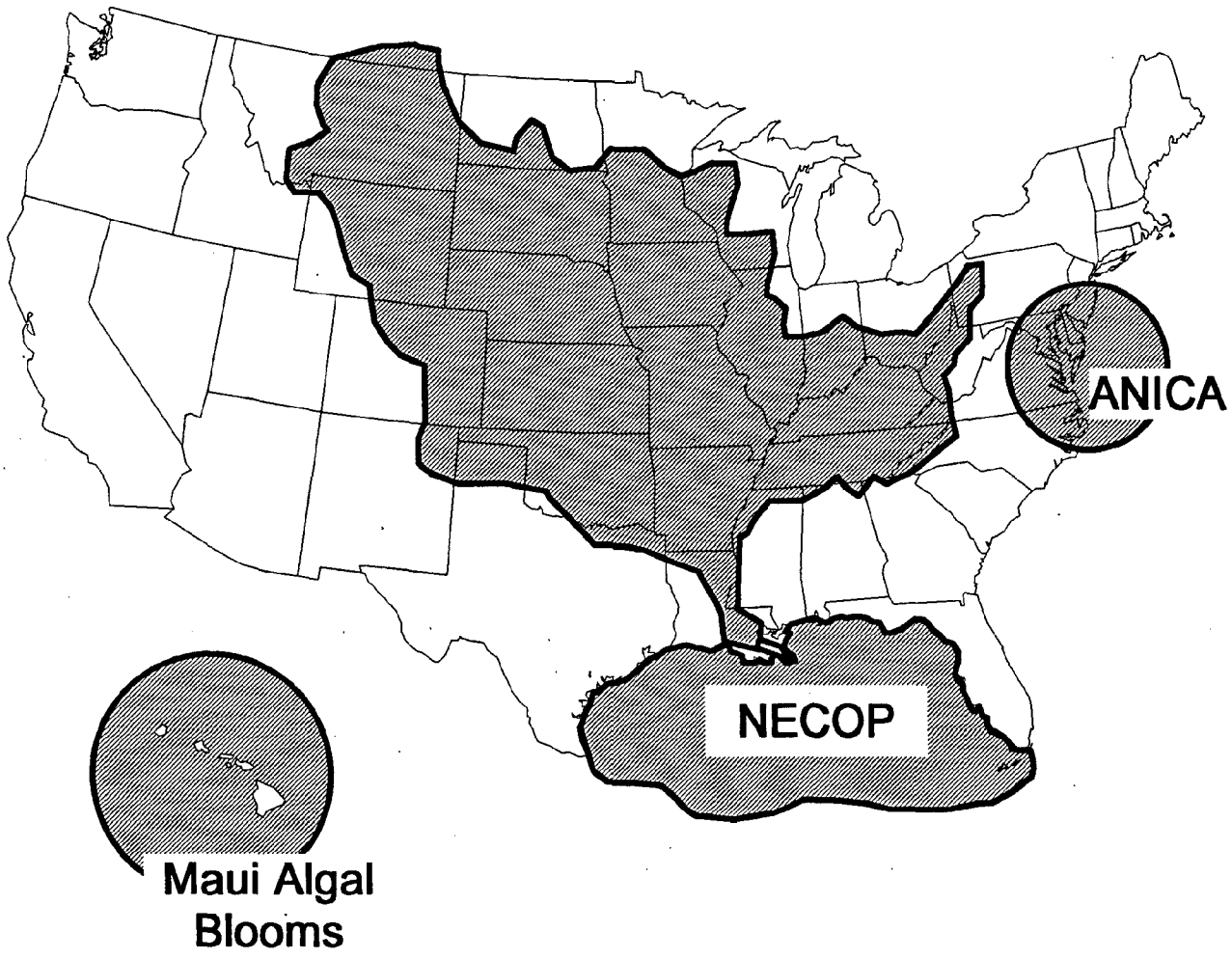
Bioeffects research was initiated in FY91, and research proposals were solicited from within NOAA and the academic community. Selection criteria required that studies be limited to species and locales for which there is documented evidence that biological effects are occurring and may be linked to contaminant exposure. Of the 50 preproposals received, 14 were reviewed by a panel of NOAA and non-NOAA scientists as full proposals and five were funded.

The five studies funded represent a broad range of species, locales, types of contaminants, and types of biological effects. Several represent cost-effective NOAA/University or EPA/University collaborative efforts. Bioaccumulation research was a FY92 planning initiative. Initial efforts have been built on the intensive surveys being conducted in selected estuaries around the country. In FY93, sampling locations were added to improve the understanding of the physical, chemical, and biological factors that control uptake and bioaccumulation of toxic materials. Similar studies with fishes were undertaken to better understand the relationships between uptake of contaminants and biological and biochemical responses. In addition, physical factors (e.g., salinity, temperature) that may influence the bioavailability of contaminants were measured.

NOAA COASTAL OCEAN PROGRAM

Nutrient-Enhanced Productivity

Key Projects and Locations



NUTRIENT ENHANCED COASTAL OCEAN PRODUCTIVITY (NECOP)

THE ISSUE:

Nutrient loadings from land-based pollution sources can greatly enhance coastal primary productivity, often with adverse impacts. One common effect of nutrient enrichment, increased algal production, often results in the depletion of oxygen from bottom waters (hypoxia), which can kill benthic marine organisms.

THE APPROACH:

The Mississippi River is the single largest source of anthropogenic nutrients to the coastal waters of the U.S. NECOP is a five-year study on the physical, chemical, biological, and geological processes that relate to anthropogenic nutrient enrichment and productivity in the vicinity of the Mississippi/Atchafalaya River outflows. NECOP aims to determine the extent to which land-based nutrients enhance coastal productivity, and impact water quality. The NECOP Mississippi/Atchafalaya River Program began in 1990 to examine the effects of nutrients transported by these river systems on Gulf of Mexico waters. The project is a collaborative field, modeling, and synthesis effort among NOAA and academic scientists.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

The NECOP Program, through field studies within the shelf waters of Louisiana and Texas affected by the outflows of the Mississippi and the Atchafalaya Rivers, has demonstrated that seasonal hypoxia is driven by river nutrient load. Among the findings is that the area's production has been increasing during the past century. Primary summer productivity rates in the outflow are exceptionally high and are driven by river-born nutrients including fertilizers from the drainage basin. An initial water quality computer model has been developed which allows analyses of the northern Gulf and the testing of various nutrient control strategies. This model has been made available to EPA's Gulf of Mexico Program to determine the effects of nonpoint source loads in the Gulf and to develop a nutrient enrichment action plan.

NECOP scientists are completing process studies and field monitoring in their analysis of remaining samples to assure the quality of existing data. These activities have included the study of the productivity of the Gulf's shelf/plume system, the impact of extensive hypoxia areas on the shelf, the flux of carbon through the system, and the description of the flow field in the Louisiana Bight through lagrangian-based study. NECOP scientists will synthesize their results into an understanding of the impact of nutrient enhancement, which will support and improve the existing models of the Louisiana shelf ecosystem. A full year past FY94 will be required to successfully accomplish a synthesis of the multiple but inter-related research projects in the NECOP program. Researchers will finalize the analysis of remaining samples, and workshops, working groups, and scientific meetings will be conducted to integrate the data sets.

MISSISSIPPI RIVER FLOOD ASSESSMENT REPORT

THE ISSUE:

The Great Mississippi River Flood of 1993 caused significant changes to the landscape throughout the Midwest and ultimately to the coastal zone. Since the flooding occurred at the time of year when flows into the Gulf of Mexico are normally lowest, the timing of the event and its oceanographic effects are of particular interest because of the exposure of marine ecosystems to abnormally large amounts of diluted seawater and the associated pulse of land-based pollutants.

THE APPROACH:

The Coastal Ocean Office acted as the NOAA lead for a comprehensive assessment of the oceanographic effects of the flood water inputs. The assessment integrated results of NOAA scientists and a diverse set of investigators in the academic community, as well as facilitated study coordination among agencies at both the Federal and State levels.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

The assessment found that the effects of the freshwater inflow into the Gulf of Mexico were detected not only in the northern Gulf but also in the Florida Keys and along the U.S. East Coast. The mass transport of Mississippi River water from the Gulf of Mexico through the Straits of Florida to the mid-Atlantic via the Gulf Stream is not a new phenomena, though the COP effort documented the far-reaching effects of the extreme outflow from the Mississippi in a comprehensive manner that has not been done previously. A concerted effort to track the effects of this major natural event on the coastal ocean required a broad spectrum of information from Federal and State agencies and universities. As a result of this study, it is now becoming apparent that the movement of Mississippi River water onto the west Florida shelf and beyond may be a much more common event than previously believed. The study has further demonstrated the interconnectedness of these large-scale coastal systems and has advanced our understanding of how an event in the Mississippi River watershed can directly affect coastal systems up to several thousand miles away.

The results of the findings have been published in a joint document with the National Weather Service and was released in May 1994. The report has a wide applicability to planning in coastal zone areas, and the cooperative approach taken to complete this assessment should prove beneficial as scientists continue to study the impacted coastal environments for longer term effects.

ATMOSPHERIC NUTRIENT INPUTS TO COASTAL AREAS (ANICA)

THE ISSUE:

Atmospheric inputs of nitrates, primarily from automobile exhaust and power plant emissions, are important but poorly understood sources of pollutants entering estuaries and coastal waters.

THE APPROACH:

ANICA combines monitoring and modelling to quantify the contribution of atmospheric nitrate to coastal areas, and to estimate the impacts of increased nitrogen oxide emissions. The program is initially focusing on the Chesapeake Bay, assessing the contribution of wet and dry deposition, and developing models of atmospheric deposition that can be applied to other coastal areas. Atmospheric studies will also be linked to terrestrial studies, such as the retention capacity of soils. NOAA works with the many agencies studying nutrient inputs to the Bay in order to complement ongoing research efforts.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Initiated in FY91, ANICA organized a series of workshops to focus on atmospheric modeling needs. Accomplishments and activities from 1991-93 include: assembling a database on wet deposition; measuring atmospheric nitrogen fluxes to a single calibrated catchment area within the Chesapeake Bay watershed; conducting dry deposition studies at two Bay sites; completing initial analyses to identify source regions and estimate total deposition; synthesizing existing atmospheric deposition information for the Bay in order to make it available for the development of control strategies; and completing a first assessment of areal wet deposition and its probability distribution for the Chesapeake Bay watershed. These activities have increased the awareness of the nitrogen air deposition to such a level that NOAA now co-chairs the newly formed inter-State/agency Air Subcommittee of the Chesapeake Bay Program.

FY94 initiatives aim to fill the information gaps that have been identified through the program. Researchers will work to produce areal representations of deposition velocities for the entire catchment area, to evaluate the accuracy of these quantifications through field testing, and to work with other agencies to produce strategic plans for assessing the contribution of atmospheric deposition to coastal ecosystems with initial focus on the Chesapeake Bay, but with subsequent attention to Pamlico Sound (North Carolina) and the Gulf of Maine.

ANICA hopes to publish, through a cooperative effort with several U.S. and Canadian organizations, the program's field studies to produce profiles of atmospheric deposition for the Bay and for other watersheds and coastal areas in the Northeast, to make available the refined results from modeling in the Bay, and to integrate ANICA results with other coastal ocean and Clean Air Act-mandated research to achieve a comprehensive overview of the impact of nutrients on the marine environment.

MAUI ALGAL BLOOM STUDIES

THE ISSUE:

Since 1989, the shallow waters and beaches on the west side of the Hawaiian island of Maui have been plagued by episodic blooms of macroalgae. There is concern that continued overgrowths of the macroalgae may threaten living coral reefs, the core of Hawaii's nearshore ecosystems. In addition, large accumulations of macroalgae in nearshore waters and on beaches have had a direct negative impact on Maui's tourist trade.

THE APPROACH:

Reports of macroalgae accumulations have been largely limited to the west side of Maui which has a relatively broad, shallow shelf in the lee of the Tradewinds. Some investigators believe that the biomass accumulations are the result of increased nutrient loading from terrestrial sources. However, a direct cause and effect linkage has not yet been established. NOAA will assist the State of Hawaii Department of Health by providing scientific information leading to an understanding of the cause(s) and ultimately a reduction in the severity of these macroalgal blooms.

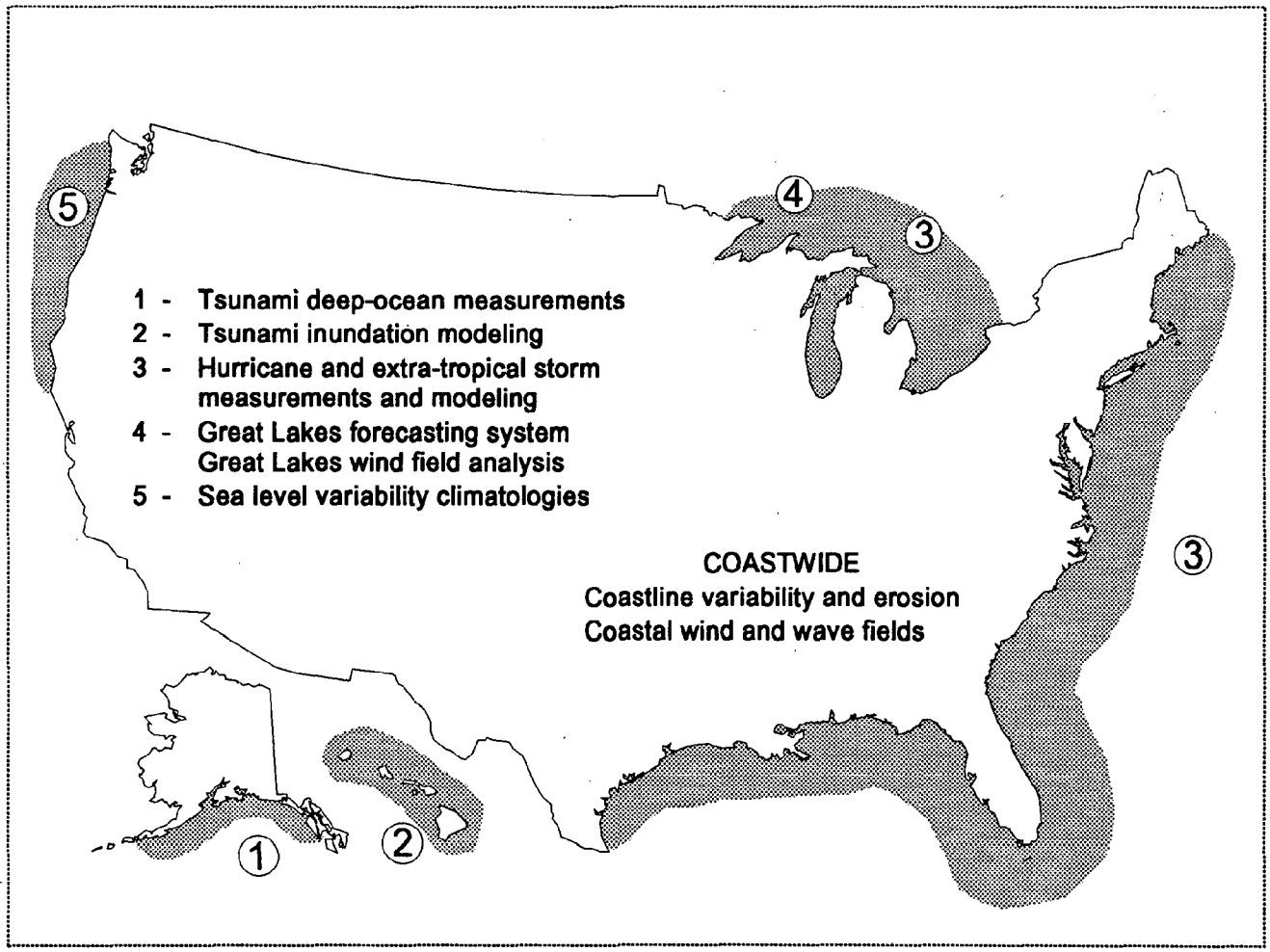
ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

The COP is currently coordinating NOAA's participation with the EPA, the State of Hawaii (Department of Health--DOH), and local officials in examining the algae problem in West Maui. NOAA's role is to assist the DOH by providing scientific information leading to an understanding of the cause(s) of the macroalgal blooms. With its 1993 Congressional appropriation, NOAA will fund research in three areas. The first area of COP-sponsored research will address mapping the algal blooms. Funds will be added to current mapping efforts which will allow the algal mapping to be expanded in both areal coverage and frequency. A second area of research includes proposed investigations by researchers of NOAA's National Ocean Service--Coastal and Estuarine Oceanography Branch into possible physical oceanographic and meteorological forcing factors which may contribute to macroalgal blooms. This effort will include an analysis of existing data for the Maui region to look for events or changes in the ocean circulation and climate around Maui that might affect macroalgal growth, biomass transport, nutrient retention in coastal waters, or other related environmental influences. Finally, the COP is funding research at the University of Hawaii to investigate the fate of land-derived nutrients in the coastal ocean off west Maui and to evaluate the degree to which nutrient enrichment may contribute to macroalgal blooms.

NOAA COASTAL OCEAN PROGRAM

Coastal Hazards

Project Sites



COASTAL HAZARDS
EXTRATROPICAL STORM SURGE MODELING

THE ISSUE:

In one way or another, all U.S. coastal populations, resources, and environments are periodically impacted by extreme natural phenomena, often resulting in loss of life and extensive property damage. Unlike tropical storms and hurricanes, which raise water levels in the vicinity of a storm as it moves ashore, extratropical storms are of relatively long duration, cover a much larger area, and can impact several tidal cycles. Therefore, while NOAA has developed a dynamical tropical storm surge model to assist in the hurricane program, this predictive tool cannot be readily applied to the extratropical flooding situation.

THE APPROACH:

The extratropical storm surge modeling effort is designed to develop a forecast method which can be incorporated into the operational framework of the National Weather Service (NWS). The goal of this project is to develop an operational, dynamical extratropical storm surge model capable of running on NOAA's computers in real time. To accomplish this goal: 1) model input and output will be standardized; 2) a rudimentary model, based on the SLOSH model (Sea, Lake, and Overland Surges from Hurricanes), will be used as a first generation extratropical model; and 3) other models will be acquired through open competition from academia and/or industry for evaluation as possible operational surge models.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

With minimal changes, the SLOSH model has been adapted to run with given meteorological input and improved for emergency preparedness and realtime forecasting for severe coastal storms like the Eastern seaboard Halloween Storm of 1991. Data have been generated for defining the grid parameters of the models. During FY 1993, the extratropical storm surge modeling effort concentrated on developing a complete set of data for testing extratropical storm surge models for model validation. A publication was written which contains the input wind and pressure data necessary for driving the model, and upgraded hurricane track books were produced for use by emergency management agencies in preparing for disasters along the Eastern and Gulf of Mexico coasts. The Techniques Development Laboratory (TDL) of the NWS solved the difficulties surrounding boundary conditions used in the "baseline" model which have improved the accuracy of the model. FY94 milestones include running a quasi-operational model on NOAA's mainframe computers daily, adapting the model to cover the Gulf of Mexico, and testing more complex models to determine the necessity of using such models for the improvement of storm surge forecasting.

COASTAL HAZARDS
TSUNAMI HAZARD REDUCTION

THE ISSUE:

Coastal communities of the United States are threatened by tsunamis that are generated by local and distant earthquakes. For local tsunamis, residents have less time to evacuate threatened coastal areas and require timely and accurate assessment of each tsunami threat. The present tsunami warning system can provide only a few of the essential pieces of quantitative information required for hazard reduction: 1) identification that a potentially tsunamigenic earthquake has occurred; and 2) issuance of the predicted arrival times. The system, however, cannot predict the size of the tsunami and the tsunami's impact when it reaches shore. The tsunami hazard reduction project is working to gather and link all the pieces of information required for improved hazard reduction.

THE APPROACH:

NOAA scientists and coastal managers have developed two tools for dealing with tsunami hazards--inundation maps and warning systems. Inundation maps identify areas that are susceptible to flooding before a tsunami occurs and are used to develop evacuation and land-use plans. The second tsunami hazard mitigation tool is a warning system to alert populations that threatened areas must be evacuated. The warnings are delivered through NOAA's Pacific and Alaska Tsunami Warning Centers. Efforts in tsunami research will provide quality control on existing NOAA products and facilitate the transfer of new technologies into warning operations.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

The COP, in partnership with NOAA OAR and NWS, has supported a research project to develop a standardized method for using numerical models to estimate tsunami inundation. From these models, scientists can produce inundation maps which indicate areas susceptible to flooding during a tsunami. These maps are used by coastal managers and planners to assist in development and evacuation planning. NOAA's Pacific Marine Environmental Laboratory (PMEL) recently developed a deep-water pressure sensor capable of detecting a tsunami in the open ocean. Sensors are currently in place in the seismically active Aleutian Trench which has a high potential for generation of tsunamis threatening Hawaii, Alaska, and the U.S. West Coast. In real time, these data will provide earlier detection of the tsunami, thus, increasing the warning lead time and providing quantitative information on the tsunami heights. This increases the accuracy of the prediction of the tsunami impact. In 1994, observation experiments in the AASZ will continue to help produce maps of tsunami inundation estimates for Hilo, Hawaii, and Eureka and Crescent City, CA. The instrumentation will be upgraded to improve the data quality and instrument pool reliability. An investigation of background sea level effects on the tsunami hazard at Crescent City, CA, and a workshop of tsunamis inundation modeling will be held.

COASTAL FORECAST SYSTEM (CFS)

THE ISSUE:

Daily operational activities, management decisions, long-range planning, and regulation in the coastal zone typically require knowledge of a myriad of environmental conditions, including weather, water levels, waves, currents, water temperature, chemical composition, and biology. A review of the current state of environmental prediction clearly shows that over the past 30 years major strides have been made in weather observing and prediction. We do not have an equivalent forecast system in place that translates the variations in weather to corresponding responses in the coastal ocean.

THE APPROACH:

NOAA, with the assistance of the COP, is actively pursuing the development of a system which would provide more specific and accurate predictions of coastal weather and ocean conditions. This forecast system would link the weather forecast system to the coastal ocean, provide feedback to the weather systems, and ultimately be coupled to biological ecological models. As coastal predictions become available and increasingly reliable, the nation will find them a necessary part of our daily lives.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

COP has facilitated a strategic plan for the Coastal Forecast System. The development of such a system involved organizing the efforts of all NOAA line offices into a comprehensive and integrated plan. When operational, the CFS will consist of all those components required to observe and predict atmospheric and oceanic conditions that impact the ecosystem and human well-being at or near the coastal boundary. Briefly, the CFS design of the future will: 1) be built on existing capabilities; 2) integrate oceanic and atmospheric observations, knowledge, and models where appropriate; 3) depend on continued R & D for many critical components; and 4) be flexible enough to accept proven new technologies and methods with little or no disruption to ongoing services.

COP is funding a feasibility study of an operational coastal nowcast/forecast system. Accomplishments to date of the study include progress on the development of an operational East Coast forecast system. Objectives for 1994 are to continue this system development; continue the establishment of data flow and access, continue skill assessment, complete the introduction of tidal capability into the model, complete a common visualization/graphics/data distribution system, begin model sensitivity experiments, conduct predictability studies, and begin development of four-dimensional data assimilation.

GREAT LAKES FORECAST SYSTEM (GLFS)

THE ISSUE:

In the Great Lakes, physical processes have a major impact on environmental, chemical, and biological processes, influencing activities such as water supply management, waste water management, power plant sitings, shipping, recreational and commercial boating and fishing, shoreline erosion, and redistribution of sediments. Planners and managers responsible for aspects of the Great Lakes ecosystems affected by lake circulation, such as transport of toxic materials or nutrients, need more information on these physical processes.

THE APPROACH:

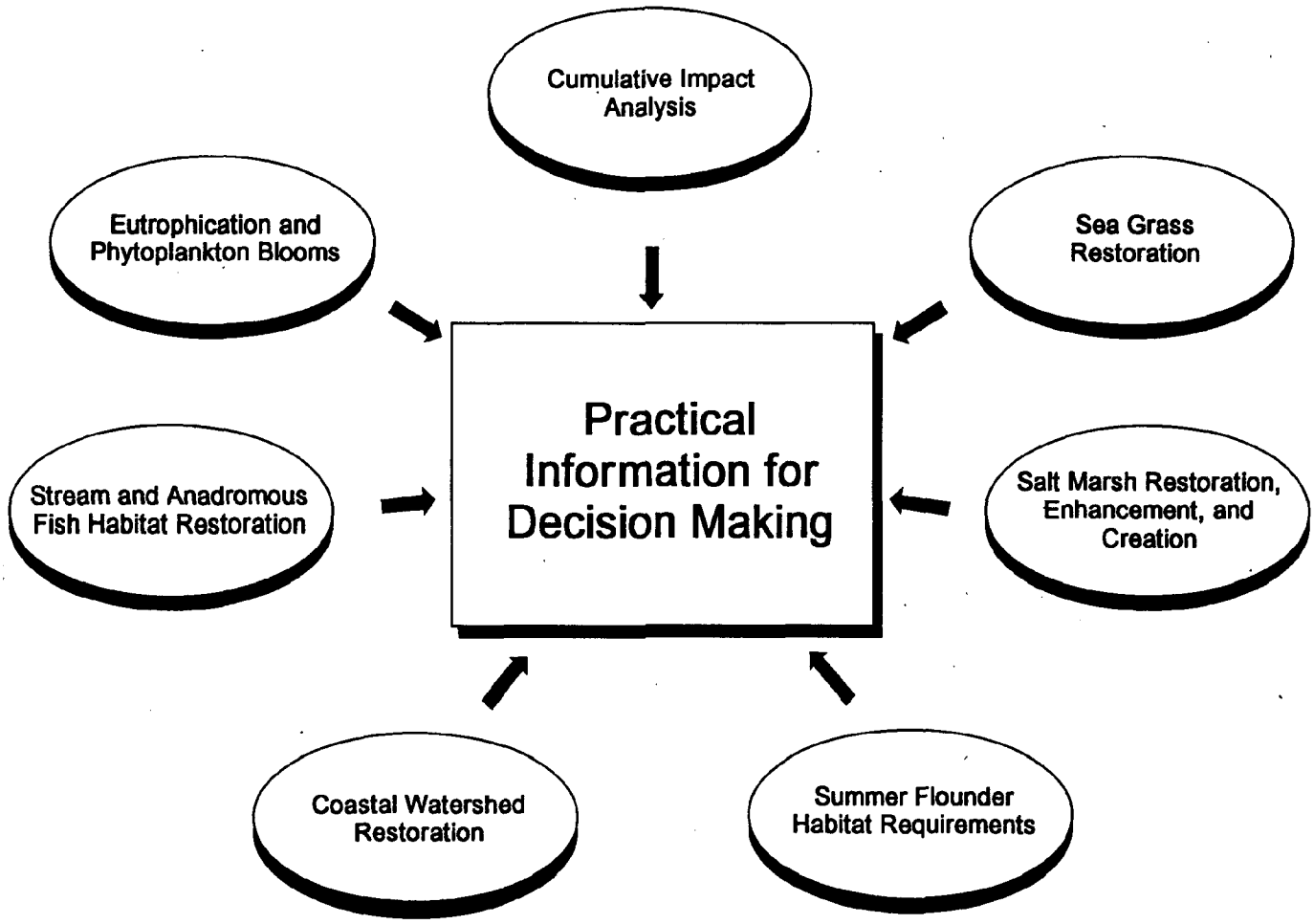
The Great Lakes Forecasting System combines data from satellite, land, and lake-based systems with computer models for real-time prediction of the physical status of the Great Lakes. The system, linking existing models, computer systems, and data networks, is a joint NOAA/academic program at NOAA's Great Lakes Environmental Research Laboratory (GLERL) and Ohio State University. The forecasting system will consist of four components: data assimilation, modeling, data display, and distribution. The data assimilation component assembles data needed for model input: National Weather Service surface and marine observations, satellite-derived water temperature data, wind forecasts, lake level observations, and other relevant data. The three-dimensional numerical model predicts currents, temperatures, and water levels. Output from the forecasting system includes maps and data sets tailored to display specific information required by particular user groups. These products will be distributed initially through GLERL and other individual CoastWatch sub-nodes.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

During FY91, daily hindcast (simulations of past conditions) and nowcast (observation and modeling of existing conditions) of the 3-dimensional distribution of water levels, currents, and water temperature were developed for Lake Erie. In FY92, the nowcasts were distributed to test sites, allowing Great Lakes CoastWatch users to evaluate their accuracy, utility, and timeliness. In addition, forecasting capability was attained which provided wave directional spectra and wave heights for Lake Erie. Transfer of this capability to Lake Michigan began in FY92, enabling evaluation of the Lake Michigan experimental forecasts during FY93. In FY93, investigations into the coupling of wind wave dynamics with three-dimensional circulation were initiated, and a suite of sample products from GLFS for display on PC-based GLFSVIEW were developed. FY94 funding will extend the GLFS nowcasts for either Lake Huron or Michigan, and nowcast surface temperature fields will be evaluated as a supplement for CoastWatch AVHRR imagery on cloudy days. Also in 1994, nowcast and 2-day forecasts of surface temperature fields, currents, and wind waves will become available for users at Lake Erie. Some of these potential users are shoreline residents, boaters, spill response teams, and commercial and recreational fishers.

NOAA COASTAL OCEAN PROGRAM

Resource Information Delivery



COASTAL OCEAN MANAGEMENT, PLANNING AND ASSESSMENT SYSTEM

THE ISSUE:

Resource managers and policy makers need information about estuarine and coastal ocean resources in readily accessible forms.

THE APPROACH:

The Coastal Ocean Management, Planning and Assessment System (COMPAS) is a user-friendly, microcomputer-based desktop information system that allows managers to access and manipulate existing coastal resource data sets. NOAA works with States to select a lead State agency to implement the project, provide matching funds, create a working group to discuss information needs and capabilities, and provide for development, training, and distribution of COMPAS. To date the system has been developed in three States with the idea of moving the program from one that needed to be developed with programmer assistance to a program that could be used by a State resource department with little outside help.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

In FY90, NOAA began working with Texas to develop a customized COMPAS for the State. The system includes NOAA data for nine estuaries on: physical and hydrologic characteristics; land use; habitats; shellfish growing waters; fish distribution and abundance; and point and nonpoint sources of pollution. In addition, the system includes Statewide data on water quality monitoring; freshwater withdrawal permits; streamflow monitoring; and wastewater discharges. The system has been completed and is now operated by the State on its own.

In Florida the COMPAS system under development is complex enough that it requires some programmer assistance but is simple enough that it is also do-it-yourself. The system should prove a powerful management tool for South Florida and the Keys. Much of the non-NOAA data has come from the Marine Research Institute of the Florida Department of Natural Resources and provides a comprehensive view of natural coastal resources in the entire area of South Florida in which the Florida Keys National Marine Sanctuary is located. The system has uses for the State management of coastal protected areas and should prove valuable as a coordination tool in the interagency restoration effort in South Florida. It will be used by NOAA and the State for the management of the Florida Keys National Marine Sanctuary when fully developed. Projected uses in the Sanctuary are for law enforcement, to store emergency response data, and to store user information for educational purposes.

A generic system of COMPAS is being developed in Oregon with much of the work being done by the State itself. A skeleton system has been put in place using data sets containing information on beach access, land use, nonpoint source assessment, and river reach. Projected uses of the system are for: 1) regulation of construction of beachfront structures; 2) fill and removal of sand/soil in seacoast areas; 3) watershed planning and management; and 4) estuarine program management.

DECISION ANALYSIS SERIES

THE ISSUE:

Assessment, synthesis and dissemination of existing coastal resource information is needed to ensure that decision makers have access to appropriate, useful information for management decisions.

THE APPROACH:

Through a peer review process, NOAA's Coastal Ocean Program has selected the following synthesis and assessment topics for funding:

- cumulative coastal environmental impact analysis;
- seagrass restoration technology;
- technology and success of *Spartina alterniflora* marsh restoration, creation, and enhancement;
- summer flounder habitat requirements;
- coastal watershed restoration information;
- techniques for restoring streams and anadromous fish habitat and the use of buffer zones as a regulatory control;
- eutrophication and phytoplankton blooms.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

COP is supporting research which will synthesize the existing information in the areas listed above. Each of these projects will produce results which will be disseminated in the form of a report, manual, or annotated bibliography evaluating all current relevant information. This information will be used by resource managers as guides which will be of practical assistance in decision making.

DECISION ANALYSIS SERIES
METHODOLOGY AND MECHANISMS FOR MANAGEMENT OF CUMULATIVE COASTAL ENVIRONMENTAL IMPACTS

THE ISSUE:

Land and water development activities continue to threaten living marine and estuarine resources along the coastal United States and the Great Lakes in three principal ways: 1) through destruction or alteration of habitat; 2) through degradation of water quality, and 3) through changes in salinity of estuarine waters. These threats are posed not only by large, new developments but also by the combined effects of multiple small development projects undertaken over a period of time.

THE APPROACH:

Most regulatory programs still assess impacts on a case-by-case basis. The assessment of the cumulative impacts of multiple stressors, however, is key to the success of regulatory and management programs for the protection of the marine and estuarine environments. The scientific community has recognized the need for the study of cumulative impacts of coastal development, and there is a fair amount of literature on assessment methodologies. These assessment approaches need to be systematically evaluated and circulated to resource managers for integration into regulatory programs.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

A principal investigator from the University of Maine Marine Law Institute is leading a study on managing cumulative coastal environmental impacts. Two documents will be produced under this project. The first will be a report designed for use by Federal, State, and local resource and land use managers involved in decisions affecting or regulating coastal development. The second product, an executive summary, will guide resource managers to more detailed discussions in the report and will serve as a self-contained document for lay readers. The report will consist of: 1) a critical synthesis of the literature on cumulative impact methodologies, including extensive references to studies, statutes and regulations, gray literature, case law, journal articles and other sources; and 2) a guidance document on the application of cumulative impact analysis to permitting processes in a fisheries habitat context, including cumulative impact assessment protocols and case studies. The report will address commonly asked questions such as the nature of the legal authority needed to consider cumulative impacts in specific programs; how the cumulative impact assessment authorization in one program differs from that in another; what the methodological options for projecting cumulative impacts on particular resources are; what the state-of-the-art models for impact assessment are; and where the sources of additional information are to be found. Because this is an evolving field, the report will be designed so it can be updated annually through the issuance of supplements keyed to specific text. Publication of this synthesis is expected in spring of 1995.

DECISION ANALYSIS SERIES
SEAGRASS RESTORATION TECHNOLOGY

THE ISSUE:

Substantial losses of highly productive seagrass habitat from anthropogenic impacts have been documented globally. Recognizing these losses, NOAA has targeted research on seagrasses as a priority within the National Marine Fisheries Service (NMFS) and the Coastal Ocean Program.

THE APPROACH:

A synthesis of applied research and practical experience is needed for the last ten years of study on the subject. This synthesis should provide uniform, scientifically defensible criteria for judging project performance, compliance, and success which will be invaluable to managers at NOAA and other Federal and State agencies dealing with management of submerged aquatic vegetation. These resource managers will be able to use this synthesis to focus on problems specific to their region of the country, but still reference the commonality of problems and solutions facing any seagrass project.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Principal investigators at the National Marine Fisheries Service's Beaufort Laboratory are preparing a synthesis of the information on seagrass restoration technology. This project is providing a significant analysis of over a decade of seagrass restoration research. This synthesis of applied research and practical experience will be presented in a modular form. Each module will represent a region of the country which can be defined based on life history strategy, population growth, and coverage rates of the seagrass involved. The document will discuss explicit environmental requirements and planting methods of each seagrass species. The project will take the ecoregional approach because all of the environmental parameters which affect seagrass habitat act together to produce regionally specific management and logistic considerations that cannot be easily generalized. Each module will contain the following topics: 1) a generic review of the ecology of indigenous seagrass species, common aspects of seagrass restoration, and management activities which have led to failures and successes; 2) a review of ecoregional activities (projects), information sources, and a summary of achievements and information gaps; and 3) an outline of the design of specific seagrass restoration/mitigation projects. Publication of this synthesis is expected by spring of 1995.

DECISION ANALYSIS SERIES
TECHNOLOGY AND SUCCESS OF *SPARTINA ALTERNIFLORA* MARSH RESTORATION, CREATION, AND ENHANCEMENT

THE ISSUE:

Coastal development, sea level rise, and land subsidence have resulted in extensive losses of estuarine salt marsh habitat throughout much of the United States. Concomitant with this habitat loss is the loss of salt marsh functions. In many areas marshes provide a protective habitat with an abundance of food for shrimp, crabs, and fish. Efforts to implement a "no net wetland loss" policy in the United States will require a continuation and expansion of programs to restore and create salt marshes in regions of deteriorating coastal wetlands. Resource managers, habitat researchers, and coastal planners need assistance in developing marsh restoration projects.

THE APPROACH:

Restoring the functional value of salt marshes often requires more than replacing or creating vegetative cover, but the literature documenting the necessary further efforts is scattered and not readily available. A synthesis of these data would be valuable for determining the most appropriate restoration and creation techniques applicable to different coastal areas.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Two principal investigators at the National Marine Fisheries Service's Galveston Laboratory are producing a synthesis on salt marsh restoration, enhancement, and creation technology. This project will produce two electronic databases and three products that will be useful in the development of future projects to restore, enhance, and create salt marsh habitats in the estuarine or coastal environment. The synthesis will concentrate on *Spartina alterniflora* and summarize information from past projects conducted throughout the coastal United States. It will include the identification of all sites in the coastal U.S. where *Spartina alterniflora* has been transplanted. Information will include the time of planting (year and season), size of the project (hectares), coastal conditions (wave energy, fetch, exposure, salinity regime, sediment characteristics, tidal amplitude, and elevation), and the success of the project in terms of short-term growth, coverage of vegetation, and the longevity of the marsh. In addition, any information on use of the marshes by estuarine animals will be recorded and summarized. The document will be available in September 1994.

DECISION ANALYSIS SERIES
HABITAT REQUIREMENTS FOR SUMMER FLOUNDER

THE ISSUE:

The summer flounder *(Paralichthya dèntatus)* is heavily over exploited. Commercial landings in 1989 were the lowest in the past 15 years, and recreational landings in 1989 were 20% of the average for the last decade. In response to this well-documented decline, the Mid-Atlantic Marine Fisheries Council is preparing Amendment #2 to the Fishery Management Plan for this species. This amendment will have a major impact on all aspects of the fisheries for this important species.

THE APPROACH:

Despite the importance of the management plan to the future status of summer flounder populations and fisheries, there are important gaps in our knowledge such as estimates of recruitment. Some of the major unknowns concerning appropriate management for summer founder are habitat related. Results from habitat related studies need to be summarized so that habitat managers can use this information to protect or enhance important nursery habitats.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Two principal investigators at the Institute of Marine and Coastal Sciences at Rutgers University have produced a document on the habitat requirements of the summer flounder. This includes a synthesize of available literature on habitat requirements of all life history stages (egg, larvae, young-of-the-year, adult) of summer flounder throughout its range (Georgia to Massachusetts), including maps of distribution of each life history stage where appropriate. This project also incorporates unpublished data from Federal, State, and academic institutions into the synthesis and a detailed listing of user groups for the synthesis. Further, a list of individuals with expertise in the habitat requirements of all life history stages of summer flounder has been compiled. This document has been published and is available from the Coastal Ocean Program Office upon request.

DECISION ANALYSIS SERIES
COASTAL WATERSHED RESTORATION AND COMMUNITY-BASED AQUATIC HABITAT PROTECTION

THE ISSUE:

Close to 60 percent of California's 113 native fish groups are at risk of becoming extinct, or have already become extinct, through the degradation of their habitat. The California legislature has funded a number of watershed and fisheries restoration efforts in recent years, through the Departments of Fish and Game and Forestry and the State Coastal Conservancy, while many grassroots organizations have formed to investigate concerns over proposed development projects that may damage this habitat.

THE APPROACH:

A document in a format where timely and focused information is accessible and easy to disseminate has the potential to enhance watershed and fisheries restoration and advocacy for coastal stream protection. Such a document would also contribute significantly to the implementation of State coastal management programs as well as to the efforts of NOAA, the U.S. Fish & Wildlife Service, and other State resource agencies.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

A private consulting firm is producing a document on coastal watershed restoration and community-based aquatic habitat protection. This project will develop and disseminate to resource managers and interested individuals timely and focused information regarding the regulatory, funding, and technical tools available to aid coastal watershed restoration. This manual will: 1) focus on best management practices/restoration techniques that have been demonstrated to be effective in other watershed restoration projects; 2) present methods for determining where improvements are needed; 3) present specifications for the appropriate application of the techniques; 4) identify technical resources to assist restoration programs; 5) present a bibliography for further research; 6) provide a primer on programs that offer grants to assist restoration efforts; and 7) identify permit requirements and agency certifications needed in order for a restoration project to go forward. Publication of this synthesis is expected in the winter of 1994.

DECISION ANALYSIS SERIES
RESTORING STREAMS AND ANADROMOUS FISH HABITAT AFFECTED BY LOGGING

THE ISSUE:

In the past two centuries, land-use activities, including logging, have degraded the majority of this Nation's streams and fish habitat, especially anadromous fish habitat. Logging has multiple effects on stream ecosystems through its effects on the riparian zone and on upland areas. Much is known about the habitat requirements of salmonids and the response of these fish to environmental change. Because of this knowledge and the magnitude of habitat loss, there is a great opportunity for effective habitat restoration.

THE APPROACH:

Many techniques exist for restoring logged streams to a natural condition, resembling their pristine state, but many techniques have not been thoroughly evaluated as to their effectiveness in restoring fish habitat. There is a need to synthesize the important information on stream restoration into a single document for resource managers.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Principal investigators at the National Marine Fisheries Service's Auke Bay Laboratory are compiling a synthesis on the techniques for restoring streams and anadromous fish habitat and the use of buffer zones as a regulatory control. Because restoration is needed on the many streams logged without streamside protection and because the use of buffer zones as a management tool will increase in the future, there is an opportunity to synthesize into one document: 1) the effectiveness of different restoration techniques in restoring fish habitat; and 2) the design and effectiveness of buffers in protecting fish habitat from logging. Sources for compiling information on stream restoration techniques and buffer zone design and effectiveness will include consultation/interviews with associates and noted experts, specific literature searches, and the unpublished literature of the many State and Federal agencies. Information on the impacts of logging on fish habitat and on stream rehabilitation will be synthesized and directed at resource managers. A panel of experts on stream restoration and buffer zone protection will be convened to identify critical needs for the Pacific Northwest and Alaska region with application nationwide. The document will be published with a format for being updated every five years. Publication of this synthesis is expected in the winter of 1994.

DECISION ANALYSIS SERIES
EUTROPHICATION AND PHYTOPLANKTON BLOOMS

THE ISSUE:

Human activities have greatly increased the loading of nutrients to the estuaries and coastal zone in the United States. Two of the symptoms attributed to nutrient enrichment are increases in phytoplankton biomass and the occurrence of nuisance phytoplankton blooms. These can lead to loss of valuable food resources and human poisoning. While the discovery of the relationship between phosphorous loadings and phytoplankton abundance has greatly aided in the management of lakes and reservoirs, this understanding is not nearly so advanced in coastal ecosystems.

THE APPROACH:

While it is generally found that nitrogen is the limiting nutrient in coastal waters, attempts to relate nutrient loading to phytoplankton abundances frequently have not yielded particularly useful relationships. There appear to be a number of factors that must interact to cause a bloom. Thus, an assembly of papers that investigate the relationships between nutrient loading and total phytoplankton abundance and those that consider the occurrence of nuisance species in coastal ecosystems would be useful for managers to determine the critical factors.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

Two principal investigators at the University of Rhode Island are producing two documents on eutrophication and phytoplankton blooms. The first will compile an annotated bibliography of references pertaining to two topics in marine eutrophication: 1) investigations of the relationships between nutrient loading and total phytoplankton abundance; and 2) studies of the occurrence of nuisance species in coastal ecosystems. Management options for reducing problems will be the focus in presenting both topics. Both hard copy and electronic versions of the bibliography will be prepared. The second document will review the current understanding of the relationships between nutrient loadings to coastal ecosystems, phytoplankton abundance, and the occurrence of nuisance and toxic blooms. Publication of this synthesis is expected in the fall of 1994.

BIBLIOGRAPHY OF SYNTHESIS DOCUMENTS

THE ISSUE:

The use of books and articles on topics which relate to the coastal ocean is limited by the plenitude of available materials. It is hard for a coastal resource manager working independently to get the right pieces of information for a decision from all the material available.

THE APPROACH:

The Coastal Ocean Program had funded the NOAA Library to undertake bibliographic searches of important databases containing scientific and management materials regarding the coastal ocean over the last ten years and then to distill the results of these searches and present them in a bibliography.

ACCOMPLISHMENTS AND CURRENT ACTIVITIES:

The database searches which were conducted in 1993-94 turned up thousands of citations on a limited number of search terms. These have been distilled to about 500-600 key articles or article collections and are being formatted into a number of keyword categories. The document is scheduled for publication in fall of 1994.

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