NOAA Technical Memorandum NMFS-F/NEC-49

Northeast Fisheries Center

Framework for Inshore Research

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Center
Woods Hole, Massachusetts
July 1987

Under the National Marine Fisheries Service's mission to "Achieve a continued optimum utilization of living resources for the benefit of the Nation," the Northeast Fisheries Center (NEFC) is responsible for planning, developing, and managing multidisciplinary programs of basic and applied research to: (1) better understand the living marine resources (including marine mammals) of the Northwest Atlantic, and the environmental quality essential for their existence and continued productivity; and (2) describe and provide to management, industry, and the public, options for the utilization and conservation of living marine resources and maintenance of environmental quality which are consistent with national and regional goals and needs, and with international commitments.

The timely need for such information by decision makers often precludes publication in formal journals. The *NOAA Technical Memorandum NMFS-F/NEC* series provides a relatively quick and highly visible outlet for documents prepared by NEFC authors, or similar material prepared by others for NEFC purposes, where formal review and editorial processing are not appropriate or feasible. However, documents within this series reflect sound professional work and can be referenced in formal journals. Any use of trade names within this series does not imply endorsement.

Copies of this and other *NOAA Technical Memorandums* are available from the National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22161. Recent issues of *NOAA Technical Memorandum NMFS-F/NEC* are noted below:

35. ***Annual NEMP Report on the Health of the Northeast Coastal Waters, 1982.*** By John B. Pearce, Carl R. Berman, and Marlene R. Rosen, eds., and Robert N. Reid (benthos), Catherine E. Warsh (water quality), and Edith Gould (biological effects), topic coords. January 1985. xi + 68 p., 29 figs., 5 tables. NTIS Access. No. PB85-219129/AS.

36. ***Growth and Survival of Larval Fishes in Relation to the Trophodynamics of Georges Bank Cod and Haddock.*** By Geoffrey C. Laurence and R. Gregory Lough. January 1985. xvi + 150 p., 67 figs., 15 tables, 1 app. NTIS Access. No. PB85-220093/AS.

37. ***Regional Action Plan: Northeast Regional Office and Northeast Fisheries Center.*** By Bruce E. Higgins, Ruth Rehfus, John B. Pearce, Robert J. Pawlowski, Robert L. Lippson, Timothy Goodger, Susan Mello Roe, and Douglas W. Beach. April 1985. ix + 84 p., 4 figs., 6 tables, 9 app. NTIS Access. No. PB85-219962/AS.

38. ***The Shelf/Slope Front South of Nantucket Shoals and Georges Bank as Delineated by Satellite Infrared Imagery and Shipboard Hydrographic and Plankton Observations.*** By J. B. Colton, Jr., J. L. Anderson, J. E. O'Reilly, C. A. Evans-Zetlin, and H. G. Marshall. May 1985. vi + 22 p., 14 figs. NTIS Access. No. PB85-221083/AS.

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Northeast Fisheries Center Framework for Inshore Research

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EXECUTIVE SUMMARY

The role of the Northeast Fisheries Center in inshore waters is to integrate scientific information and conduct research necessary to support fishery conservation and management goals and objectives for species that move between inshore (generally inside three miles) and offshore habitats, or that occur alongshore over a major portion of the Atlantic coast from Maine through Virginia.

As a component of the National Marine Fisheries Service (NMFS), the federal agency with primary responsibility for conserving and managing living marine resources and their habitats, the Center takes a broad, regional perspective of the status and condition of living marine resources that depend on inshore habitats.

The primary users and beneficiaries of the products generated by the Center's inshore research program are the NMFS's Northeast Region and the Regional Fishery Management Councils. Many other agencies and organizations will also benefit through implementation of an efficient, responsive, and cost-effective program. The success of the program depends on coordination and cooperation with state and local governments, academia, the Atlantic States Marine Fisheries Commission (ASMFC), other components of the National Oceanic and Atmospheric Administration (NOAA), other federal agencies, the marine recreational fishing community, and various public and private organizations.

The Center's Framework for Inshore Research embodies the Regional Action Plan (RAP) concept by identifying the highest priority habitat issues and threats to living marine resources in the Northeast, setting priorities for needed information syntheses and new research, and laying the foundation for addressing the highest priority issues using all appropriate NMFS components.

The inshore research program focuses on addressing the threats to living marine resources caused by various forms of contamination (toxic chemicals, nutrient overenrichment, pathogens, and disease), physical habitat alteration and loss, and fishing, as well as on garnering knowledge of the causes of and trends in natural system variability, so that changes related to these threats can be detected.

The Framework provides criteria for choosing species and study sites, and lists products that need to be developed to accomplish the program's objectives. It also describes the

various phases through which each of the major inshore research activities should progress, and indicates the linkages among the objectives and products associated with each major component of the Framework.

The Center's inshore research program is aligned with conservation and management needs of the Region and Center that fall into four major categories: (1) data and information management, (2) habitat requirements and use, (3) biological effects of habitat degradation, and (4) fishery statistics and stock assessments.

The top priority for implementing new projects proposed in the Framework is completion of the tasks associated with creating and using the Inshore Data and Information Management System (IDIMS). Assembly, synthesis, and evaluation of available information that defines inshore habitat requirements and use by important living marine resources is the next highest priority.

The highest priority ongoing projects are: (1) research on the population- and fishery-level effects of contaminants on the reproductive success of winter flounder and American lobster; and (2) cooperative state/federal efforts to develop a shared network of fisheries statistics data, and to conduct stock assessment workshops that deal with inshore species on a regular basis.

Major products include: (1) improved knowledge on the relationships among inshore habitats, human activities, living marine resource populations, and fishery yields; (2) summaries and evaluations of available knowledge; (3) an interactive data and information management system; (4) improved capability for predicting abundance and availability of fishery resources; (5) risk assessments and evaluations of alternative management strategies; and (6) research plans to fill gaps in knowledge.

The Framework recommends that the Center: (1) prepare a major budget initiative for FY89 that expands the capability of the Center, Region, and cooperators to address the Framework's objectives; (2) begin consolidating present inshore research projects into a cohesive program; (3) begin assembling and evaluating information on habitat requirements and use; (4) accelerate and expand cooperative efforts to develop and implement a shared fisheries statistics network with the states, and continue cooperative semi-annual stock assessment workshops; (5) develop operational approaches for accomplishing the Framework's objectives, with or without additional funding (i.e., develop detailed research plans and conduct the necessary inshore research).

I. INTRODUCTION

Many federal laws authorize NOAA to address virtually all facets of research, assessment, and resource use in estuarine, nearshore, and offshore waters of the United States. Recognizing the great importance of estuaries to our society, the U.S. Congress recently passed the Water Quality Act of 1987 that, among other things, establishes a National Estuary Program. Implementation of this program will be a cooperative effort of NOAA and the U.S. Environmental Protection Agency (EPA). NOAA has already responded to several of the problems identified in connection with the designated estuaries through its Chesapeake Bay Study and EPA-funded efforts in other estuaries. NOAA's Estuarine Framework also addresses many of the needs of the National Estuary Program.[1]

The Magnuson Fisheries Conservation and Management Act (MFCMA), Marine Mammal Protection Act, Endangered Species Act, and other laws give NMFS the primary responsibility for conserving and managing living marine resources. Over 20 U.S. Department of Commerce, NOAA, and NMFS policies also affect the direction of NMFS's research programs, including the National Program for Marine Fisheries, the Estuarine Policy, the Fisheries Development Policy, the Marine Recreational Fisheries Policy, the Habitat Conservation Policy, the Habitat Alterations Policy, and Guidelines for Fishery Management Plans.

The NMFS's Northeast Fisheries Center conducts, coordinates, and supports scientific investigations relevant to resolving issues concerning productivity and harvest of fishery resources throughout their range. The Center is composed of a Center Directorate, supported by Research Planning and Coordination (RPAC), Program Support, and Data Management Support (DMS) staffs; three Divisions -- Conservation and Utilization (CUD), Fisheries Ecology (FED), and Environmental Processes (EPD); and the National Systematics Laboratory (NSL) (Figure 1). Center scientists at laboratories in Woods Hole MA, Gloucester MA, Narragansett RI, Milford CT, Sandy Hook NJ, and Oxford MD conduct research in several inshore areas along the northeast U.S. coast, as well as in the offshore ecosystem.

Waters within three miles of the Northeast coast provide essential spawning and nursery habitat for many important living marine resources. Noteworthy species dependent on

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[1] "NOAA Estuarine and Coastal Ocean Science Framework." Manuscript. NOAA Estuarine Programs Office, Washington, D.C.

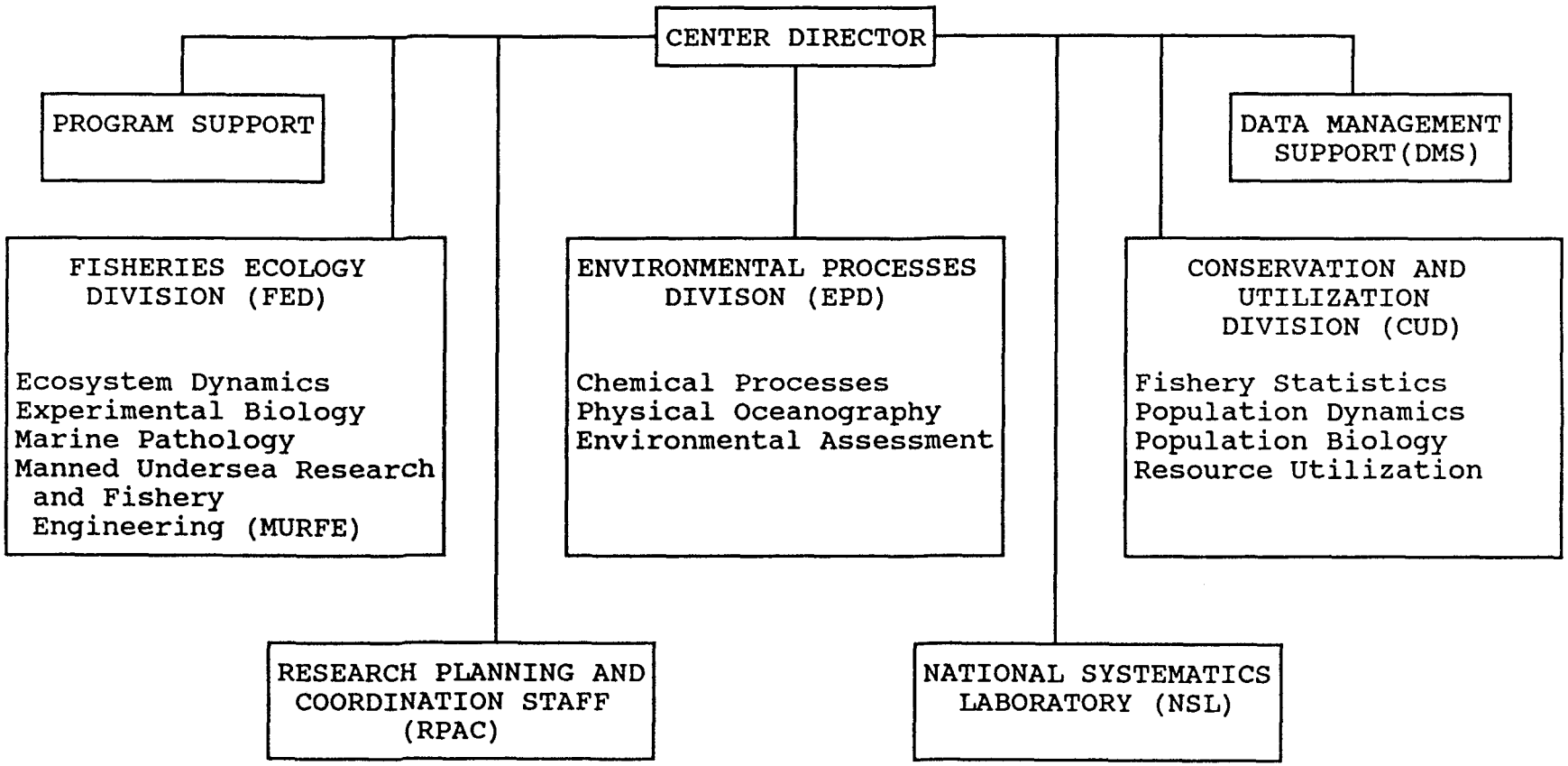

Figure 1. Organization of the Northeast Fisheries Center

these inshore waters during at least part of their life cycle include anadromous and catadromous fish (e.g., striped bass, American shad, blueback herring, menhaden, alewife, Atlantic salmon, American eel); coastal migratory fish (e.g., bluefish, scup, weakfish, black sea bass, summer flounder, windowpane flounder); fish and shellfish common to, and residents of, a wide geographic range of inshore waters (e.g., winter flounder, American oyster, hard and soft shell clams, bay scallop, blue mussel, American lobster, blue crab); marine species commonly harvested in inshore waters (e.g., Atlantic cod, pollock, silver hake, sharks, squids); and marine mammals and endangered species (e.g., harbor and gray seals, Kemp's ridley and loggerhead sea turtles, shortnose sturgeon).

Fishing and hunting pressure and deterioration of inshore habitats have contributed to decreased abundance and yields of many species. Moratoria have been declared on harvesting of some species to help their populations recover. Shellfish areas have been closed due to contamination by human pathogens discharged from municipal sewage treatment plants and other sources. Fish kills have been caused by contaminants and hypoxia that, in turn, are linked to accidental spills, waste discharges, agricultural and urban runoff, and other factors. Degraded environments have been linked to increased incidence of disease and abnormalities in demersal fish and shellfish. Several species contain levels of contaminants in edible tissues that are serious cause for public concern. Commercial sale of some species has been banned, and health advisories have been issued to recreational fishermen. Construction of dams and freshwater diversions has denied anadromous fish access to historic spawning areas; altered salinity profiles in estuaries; and possibly expanded the range of diseases, parasites, and predators associated with higher salinities. Impoundments may restrict natural tidal flows, reduce transport of detritus and nutrients to and from salt marsh wetlands, and impede movements of fish and shellfish. Dredging, filling, and in-water construction activities continue to destroy valuable wetland areas and degrade water quality at a rate commensurate with human population growth and activities along the coast.

The federal laboratories conducting marine fisheries research in the Northeast have been involved in inshore research activities throughout their 100-year history. Some laboratories (Oxford, Sandy Hook, and Milford) were established specifically to conduct research in inshore waters. In 1976, the NMFS laboratories were consolidated into the Northeast Fisheries Center, and more emphasis was placed on addressing problems and issues associated with passage of the MFCMA; the inshore research program became a

proportionally smaller component. In the 1980s, however, renewed Congressional interest in water quality and NOAA/NMFS policies and directives related to habitat conservation led toward a greater research emphasis on those factors affecting the productivity of living resources in inshore environments.

The Center conducts independent investigations and participates in cooperative research and monitoring programs that relate fishing and inshore and offshore habitat alterations to biological effects and fishery yields (Table 1). An interagency agreement with EPA provides for cooperative research on the biological effects of contaminants in Long Island Sound and Narragansett Bay. Cooperative agreements with Maryland, Virginia, the District of Columbia, and Pennsylvania State University provide for joint development of a program to examine the combined effects of fishing and pollution on the fishery resources of Chesapeake Bay.

The Center's Fiscal Year 1987 (FY87) inshore research projects (Table 1) focus on the biological effects of habitat degradation, particularly those associated with contaminants, and on several species that support inshore fisheries (winter flounder, hard clam, oyster, and lobster). Field and laboratory work includes examination of the biological, physical, and chemical processes that affect growth and reproduction. Studies range from those on cytogenetic effects of pollution on development of fish and shellfish to broad-scale examination of the effects of contamination on recruitment success of species in several estuaries. The relationship between contaminant loadings and the occurrence of pathogens in fish and shellfish is also being examined, and cooperative inshore surveys and stock assessment programs are being conducted in New England coastal waters and in Chesapeake Bay, Long Island Sound, Buzzards Bay, and Narragansett Bay. The Center supports or conducts these studies in cooperation with state agencies, other elements of NOAA, other federal agencies, and academic institutions.

Because of the collective desire of federal, state, and private institutions to understand the factors affecting productivity and utilization of inshore waters, a clear statement of the Center's research program in these systems is necessary. The purpose of this document is to present such a statement, putting it in the context of the Center's role in inshore waters and the "Core emphasis" of the Center's research program.

The inshore research program outlined in this document is consistent with the NOAA Estuarine and Coastal Ocean Science Framework, and provides a framework for the Northeast's contribution to a cost-effective and responsive

Table 1. Inshore Research Projects of the Northeast Fisheries Center in FY87.

Brief Project Title	Site[1]	Cooperator[2]	Center Lead[3]
Emergency Striped Bass Study o Maturity of Striped Bass o Discrimination of Stocks o Stock Assessment	Regional	FWS States	CUD
Assessment of Effects of Pollutant Exposure on Estuarine Populations	Regional	EPA,FWS States	CUD
Cooperative Fisheries Statistics Program	Regional	States	CUD
Juvenile Winter Flounder Age & Growth Based on Otoliths	Regional	FVSC	CUD
Life History Studies of Molluscs	LIS	NURP	FED
Occurrence of Bacterial Pathogens of Oyster Larvae	LIS		FED
Cytogenetic Effects of Pollution on Development of Fish & Shellfish	LIS,BH		FED
Algal Population Studies	LIS		FED
Chemical Composition of Seston	LIS		FED
Growth & Reproduction of Winter Flounder	LIS	EPA,OAD	FED
Growth & Reproduction of Lobster	LIS,BB	EPA,OAD	FED
Effects of Contaminants on Growth, Reproduction, and Metabolism of Winter Flounder	NB	EPA	FED
Comparative Pathobiology -- Disease & Environmental Effects o Comparative Invertebrate Pathology o Fish Pathology	Regional		FED
Effects of Estuarine Cultural Eutrophication & Hypoxia in Coastal Habitats	RB,HRE		EPD

Table 1. (Cont'd).

Brief Project Title	Site[1]	Cooperator[2]	Center Lead[3]
Coastal Habitat Assessment, Research, & Mensuration (CHARM) Program	Regional	ORNL	EPD
Historical Trends in Benthos Biomass	NYB,HRE,LIS		EPD
Limits to Production of Estuarine Shellfish	Middle Atlantic		EPD
Behavior of Marine Fishes & Invertebrates	Regional	OSU,EPA	EPD
Chesapeake Bay Stock Assessment Program	CB	MD,VA,DC, PSU	RPAC
NOAA Status & Trends -- National Benthic Surveillance Project:	S&T Sites	OAD	
o Analysis of Extractable Organic Compounds			CUD
o Histopathological Analysis			FED
o Heavy Metals Analysis			EPD
o Benthos Studies			EPD
Cytogenetic Effects of Contaminants on Mackerel Eggs	Regional		EPD
Massachusetts Inshore Survey	MA	MA	FED, CUD
Northern Shrimp Survey	Gulf of Maine	MA,NH,ME	FED, CUD
Maine Herring Survey	ME	ME	FED, CUD

[1]BH: Boston Harbor, BB: Buzzards Bay, NB: Narragansett Bay, LIS: Long Island Sound, HRE: Hudson River Estuary, RB: Raritan Bay, NYB: New York Bight, CB: Chesapeake Bay, S&T: Status and Trends

[2]FWS: Fish and Wildlife Service, EPA: U.S. Environmental Protection Agency, FVSC: Fort Valley State College, OAD: Ocean Assessments Division, NURP: National Undersea Research Program, ORNL: Oak Ridge National Laboratory, OSU: Oregon State Univ.

[3]see Figure 1 for acronym definitions

national estuarine program for the 1990s. Detailed research plans will be developed for each component of the Center's program once funding is assured.

Products generated through implementation of the Center's inshore research program will benefit a variety of agencies and organizations. NMFS's Northeast Region will gain more complete and timely information for use in evaluating alternative habitat conservation and fisheries management strategies. NOAA will have an integrated regional program that provides timely and accurate predictions of potential impacts of habitat degradation on the status and harvest of living resources in inshore waters. Other federal agencies will be able to use the information on inshore living resources in their environmental impact analyses and hazard or risk assessments. State and local governments in the Northeast will gain a regional perspective of the status and condition of the resources they conserve and manage. The Fishery Management Councils and the ASMFC can use the information to satisfy their requirements for addressing habitat issues in their fishery management plans. The marine recreational fishing community, which focuses primarily on inshore species, will benefit from the improved accuracy, completeness, and timeliness of fishery statistics and stock assessments, as well as information related to contamination and habitat loss. The recreational and commercial fishing industries can use this information to document the importance of their fisheries, and to plan business operations in a more efficient and cost-effective manner.

II. THE CENTER'S FRAMEWORK FOR INSHORE RESEARCH

A. THE ROLE OF THE CENTER IN INSHORE WATERS

The Center is obligated to develop a basic understanding of the productivity of living resources of the Northwest Atlantic, and to predict the effects on fishery yields of natural and man-induced changes to the ecosystem. In meeting its obligation, the Center must, first and foremost, respond to the information requirements of the Northeast Region and the New England and Mid Atlantic Regional Fishery Management Councils.

To realize the full potential productivity of the nation's fishery resources, fishery managers must develop strategies, impose management regimes and regulations, and monitor progress. As an integral part of this process, the Center's "Core emphasis" must, at a minimum, be able to determine the restraints that resource productivity impose on management. Therefore, the "Core emphasis" of the Center's research program is to define the limits of fishing and habitat degradation in the Northwest Atlantic that still assure living resource populations can sustain themselves at levels consistent with prevailing fishery management policies and goals.[2]

Based on this emphasis, the Center's role in inshore waters is to integrate scientific information and conduct research necessary to support fishery conservation and management goals and objectives for species that move between inshore (within three miles) and offshore habitats, or that occur alongshore over a major portion of the Northeast U.S. coast.

In such a large, comprehensive endeavor, coordination and cooperation with others is imperative. Thus, although the Center's inshore research program maintains a regional perspective of the status and condition of living resources that depend on inshore habitats, the success of the program is highly dependent upon cooperation with state and local institutions, academia, public and private organizations, other NOAA elements, and other federal agencies.

Conservation and management of "inshore-dependent" living marine resources involves addressing multiple-use conflicts that frequently arise between those who wish to

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[2] "The Purpose and Direction of the Northeast Fisheries Center Research Program." Manuscript. RPAC, Northeast Fisheries Center, Woods Hole, MA.

utilize these resources or their habitats and those who wish to conduct other developmental activities in inshore areas. The Center does not have the funding or personnel necessary to address all potential conflicts; therefore, research priorities must be established.

The Northeast Regional Action Plan (RAP), implemented in 1985, identified several threats to living marine resources and habitats that are of immediate concern in inshore areas.[3] Pollution and inshore habitat alteration associated with (1) urban and port development, (2) non-point source pollution, and (3) ocean disposal were identified as being the highest priority threats. The Center's inshore research program focuses on addressing these threats to selected species and their habitats, and on obtaining general knowledge of the causes of and trends in natural system variability, so that changes related to these threats can be detected.

B. THE CENTER'S INSHORE RESEARCH PROGRAM

Formulation of an inshore research program to address the effects of pollution and habitat alteration should be based on the types of information needs that the program is expected to fulfill. The most important inshore information needs suggest four major components for the Center's inshore research program: (1) data and information management, (2) habitat requirements and use, (3) biological effects of habitat degradation, and (4) fishery statistics and stock assessments. The information and research needs, goals, objectives, products, and participants for these four components are discussed in the following sections.

The general approach to achieving an identified research objective involves several steps (Figure 2). Step 1 is to identify issues or problems and select species, areas, and habitats to study. Step 2 is to assemble, evaluate, and summarize available information. The use of generic data, which result from studies done in other temperate waters, is extremely important.

Step 3 is to develop research plans for new studies to be conducted by the Center, based on apparent information gaps. If for some reason the Center cannot produce certain missing information, or if that information is more appropriately produced by others, the criteria to meet the need should be specified and provided to the responsible

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[3] "Regional Action Plan: Northeast Regional Office and Northeast Fisheries Center." 1985. NOAA Technical Memorandum NMFS-F/NEC-37. ix + 20 p., 8 app.

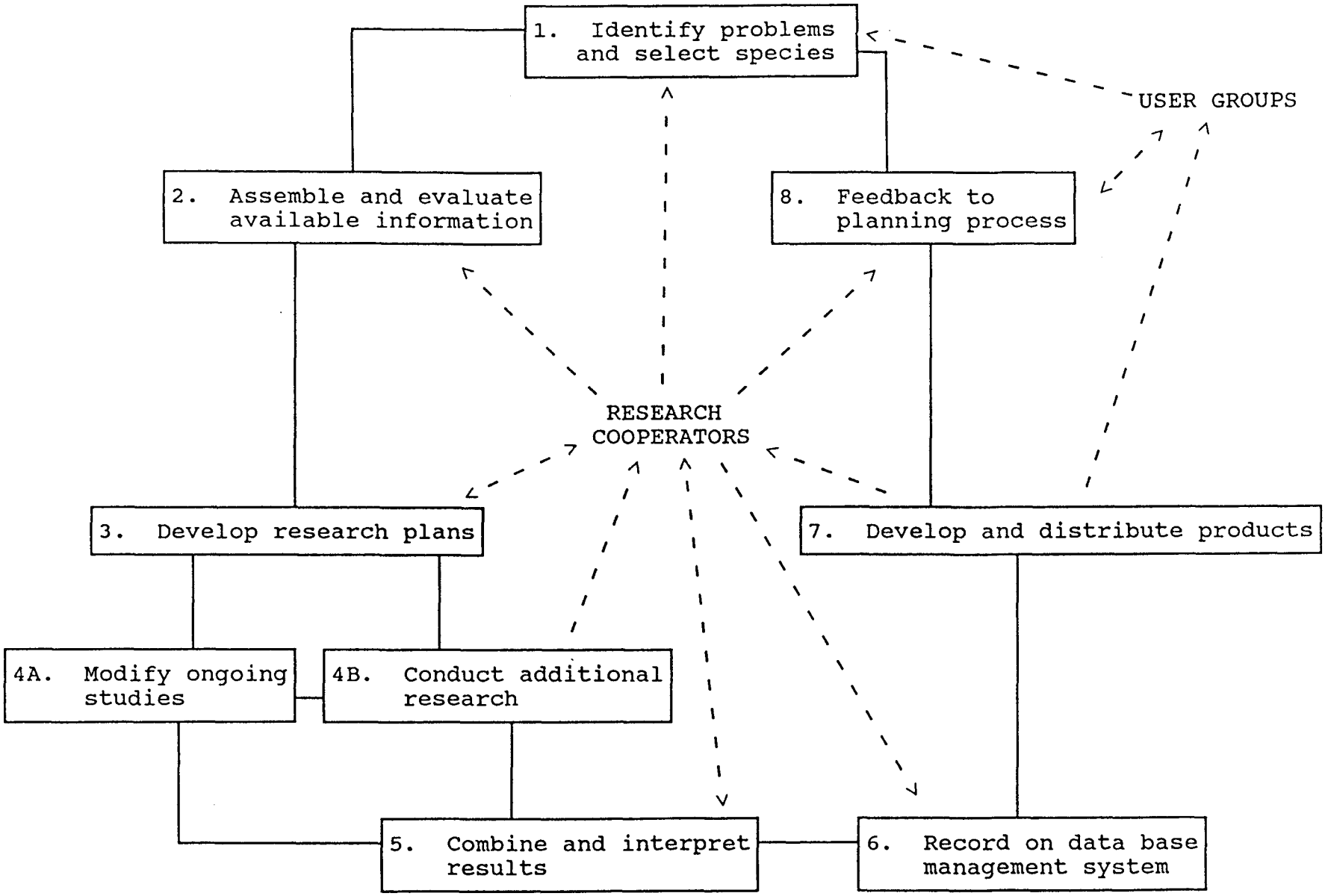

Figure 2. General study approach to inshore research.

agency, or to other potential collaborators, such as Sea Grant institutions, with which cooperative activities can be planned.

Step 4 is to modify ongoing Center research projects, as necessary, and conduct additional research. This step involves procuring equipment, developing techniques, and conducting field, laboratory, and in situ studies.

Steps 5-8 involve combining and interpreting the results of these studies, recording the data on a data base management system that permits interactive analyses and creation of integrated products, and developing and distributing interim products that represent an initial attempt to summarize the information. Interactive analyses should then be conducted, integrated products developed and distributed, and necessary program adjustments made. Research plans and products should be modified as deficiencies are identified during synthesis efforts, or as a result of feedback from users.

Obviously, the process is dynamic and flexible. Many of the steps occur simultaneously, the process recycles as more information becomes available, and not all research areas have to begin at step 1.

1.0 Inshore Data and Information Management System (IDIMS)

Fish and wildlife resource managers and regulatory agencies constantly need answers to questions about various species' inshore habitat requirements and habitat usage patterns, the biological and economic importance of inshore populations relative to entire populations, and the biological effects of inshore habitat degradation.

A prerequisite to the Center's providing the scientific basis for answering such questions is the ability to combine habitat information with biological and economic data, and to summarize and display such information in appropriate formats and time frames for the Region and other users. However, the existing data management systems in the Center do not allow easy access to this type of integrated information because the individual data bases are frequently bonded to, and are accessed only through, particular data base management systems.

Important data sets are also held by academic institutions, the states, other components of NOAA/NMFS, other federal agencies, and several industrial and consulting firms. Some of these organizations have indicated a

willingness to share data sets with NMFS but, again, a standard, interactive access system with uniform data code and format is needed to use this information effectively. IDIMS will not be a repository for all these data, but will provide an index of sources of data stored elsewhere, and contain condensed files of certain Center data in a relational data base.

IDIMS, the foundation of the Framework, will be a major component of the Center's complete data management system, which will allow interaction among inshore, and between inshore and offshore, data sets. Once developed, IDIMS will enable NMFS personnel to generate rapid and comprehensive responses to requests for information and advice on major issues affecting living resources in inshore waters. IDIMS will be capable of producing information summaries that are necessary to develop credible NMFS positions on effects of proposed habitat alterations and fishery management strategies, and will allow hazard assessments to be performed that are focused on particular species or geographic areas.

An obvious advantage of IDIMS is that information produced in response to one request (e.g., habitat requirements of species in a fishery management plan) is stored and may be used for other purposes (e.g., biological effects of proposed habitat alterations on those same species). IDIMS will also be used to track the Center's inshore research projects, and to help coordinate research efforts with the many organizations involved with the Center in inshore research.

<u>The goal of the data and information management system component of the Framework is to establish and maintain a system for the storage, retrieval, and interactive (relational) analyses of inshore data and information.</u>

To accomplish this goal, it is necessary to: (1) identify the essential core of environmental, biological, economic, and fisheries data to be incorporated in the integrated and operational data base; (2) evaluate the relative importance of the various types of data, the adequacy of available data sets for answering information needs of users, the quality assurance procedures to be followed, and the methods of accessing particular data sets; (3) develop an interim plan for data archiving until the system is fully developed and operational; (4) develop data base criteria for systematic inputs to the system; (5) develop and apply techniques and software for creating compatibility among assembled inshore data bases (i.e., create a relational data base), ensuring that IDIMS is compatible with its eventual offshore counterpart; (6) develop tutorials for NMFS staff and other users; and

(7) evaluate the usefulness of IDIMS and the resulting products, and make necessary improvements.

Anticipated IDIMS products include:

- o System design.
- o Interim plan for data archiving until system is fully developed and operational.
- o Data base format criteria for systematic input.
- o Techniques for interactive analysis.
- o Software for interaction and relational analysis of data bases.
- o An accessible, user-friendly system that may be accessed by Center scientists and administrators, and by other users.
- o Inventories of accessible data sets, tabular and graphic representations of data sets, and integrated products such as periodic atlases and information syntheses for particular geographic areas, species, and time periods.

Expected Center participants include DMS and RPAC staff who will develop and monitor private sector contracts for system development, and coordinate Center participation by appropriate CUD, FED, and EPD staff.

Definition of products and identification of data bases will be done in cooperation with NMFS's Northeast Region; Regional Fishery Management Councils; state agencies; the ASMFC; NMFS's Washington Office; academic institutions; other NOAA components such as the National Environmental Satellite, Data, and Information Service (NESDIS), the National Ocean Service's Ocean Assessments Division (OAD), the Office of Sea Grant and Extramural Programs (Sea Grant), and the Estuarine Programs Office (EPO); and other federal agencies such as EPA, the U.S. Fish and Wildlife Service (FWS), the U.S. Army Corps of Engineers (COE), the U.S. Geological Survey, the Federal Energy Regulatory Commission, the Minerals Management Service, the U.S. Coast Guard, the U.S. Nuclear Regulatory Commission, and the U.S. Department of Energy.

2.0 Inshore Habitat Requirements and Use

Effective conservation and management of inshore-dependent marine organisms depends on achieving a better understanding of the role that the quantity and quality of inshore habitats plays in the continued productivity and well-being of these species. Documentation of the importance of inshore habitats to selected species is essential to understanding why some inshore areas are more productive than others, and what the effects of any given habitat loss or alteration might be on living resource populations.

Much of the functional or ecological value of inshore habitats is related to the presence of spawning and nursery areas, but the extent to which the productivity and well-being of living marine resources are linked to the quality, quantity, and productivity of their habitats generally remains to be quantified. Similarly, although considerable research has been done, little is known about the nature of the relationships among stock size, recruitment, and production of marine organisms. Additional research is needed on the ecological factors that determine abundance and survival of larvae and juveniles. Information generated by these studies is crucial to understanding recruitment variability and the natural variability in the populations. This knowledge will help resource managers and scientists undertake risk assessments and establish criteria to protect the characteristics of inshore areas that provide for continued optimum production of living marine resources.

The goal of the habitat requirements and use component of the Framework is to develop a basic knowledge of the inshore habitat requirements, habitat preferences, and habitat usage patterns of selected species.

Major objectives associated with this goal are to: (1) define habitat requirements, preferences, and usage patterns for selected species; and (2) determine the importance of inshore habitats to marine species and populations. Species to be studied may include those of ecological importance (e.g., food organisms), as well as representative species (probably 15-20) for which NMFS bears mandated responsibility (i.e., commercial and recreational species of fish and shellfish and protected species of mammals, turtles, and fish).

To accomplish these objectives, relevant information should be assembled, evaluated, and summarized on: (1) species' distribution, patterns of movement or migration, subpopulation or stock definition, and abundance; (2) the degree of "inshore-dependency" of marine species, including residence time in, and seasonal usage of, inshore habitats by

various life history stages; (3) food requirements, food availability, and predator-prey interactions in inshore habitats; (4) the relationship of physiological requirements and behavioral characteristics to environmental characteristics of inshore habitats (e.g., sediment type, vegetation, water temperature, salinity, circulation and exchange patterns); and (5) the effects of natural environmental variations on survival, growth, maturation, behavior, reproduction, and movements.

Once this information is summarized and evaluated, additional research necessary to fill critical information gaps should be determined, research plans should be developed for conducting the highest priority studies, and planned research should be conducted in cooperation with other agencies and institutions. Techniques for creating compatibility among the data bases developed for IDIMS should be evaluated and applied to create a relational data base, and a software package should be created for storage and retrieval of habitat information to be entered on IDIMS.

Anticipated habitat-related products include:

- Matrix of status of knowledge for species' inshore habitat requirements and use.
- Research plans and research to fill gaps in matrix.
- Summaries of information on important habitat types and conditions.
- Contributions of local inshore habitats to regional population abundance (i.e., "inshore-dependency" of species and stocks).
- Relational data base on habitat requirements and use.
- Information storage and retrieval software package for relational data base.
- Input to biological effects and to IDIMS.
- Maps, atlases, and inventories of habitat usage for selected species.
- Zoogeographic (e.g., RAP "Water Management Unit") characterizations.

FED's Ecosystem Dynamics Branch, the lead Center unit for this component of the Framework, will depend on considerable help from species and habitat experts within the Center (EPD, FED, CUD, and NSL) and the Region's Habitat

Conservation Branch and State Federal Relations Branch, as well as in other NMFS Centers and Regions, other NOAA components (OAD, Sea Grant, NESDIS, etc.), other federal agencies (FWS, EPA, COE, etc.), state agencies, the ASMFC, Fishery Management Councils, and academic groups such as the Northeast Area Remote Sensing System (NEARSS) and Sea Grant institutions. Experts in these groups will be relied upon for basic biological and environmental information, and for consultation during the peer review and product development processes.

The Center will rely on NMFS Headquarters for assistance in product development, and in coordinating the Center's efforts with NOAA components such as EPO, OAD, NESDIS, and Sea Grant. RPAC, in consultation with DMS and NESDIS, will monitor contracts for developing a relational data base and associated software.

3.0 Biological Effects of Inshore Habitat Degradation

Understanding the effects of various kinds of habitat alterations on living marine resources, especially the ultimate effects on their populations, requires knowledge of the natural chemical, physical, and biological processes controlling dispersal and uptake of contaminants and pathogens, as well as information on the habitat requirements of the affected species. Consequences of continued inshore habitat degradation can only be assessed and predicted with knowledge of how, and to what degree, natural environmental processes may counteract man-caused habitat degradation.

The sources of habitat degradation to be studied at the Center are: (1) contaminants, including (a) toxic chemicals (synthetic organics, petroleum hydrocarbons, heavy metals), (b) nutrient overenrichment (causing eutrophication and hypoxia), and (c) diseases and pathogens; (2) physical habitat alteration and loss; and (3) cumulative effects of (1) and (2) in the presence of fishing mortality.

The ultimate goal of biological effects studies is to link effects on individual organisms to effects on populations and fishery yields. Accomplishing this goal involves the difficult task of determining the mortality rate due to a given source of habitat degradation. Source-specific mortality rates, combined with source-specific effects on growth, behavior, and reproduction, are necessary for examining the effects of cumulative stress due to habitat degradation and fishing.

The Center initially will focus its biological effects studies on species selected using the following criteria: (1) the species is a known or suspected indicator of inshore habitat degradation; (2) inshore habitat is essential to the life cycle of the species; (3) the species has socio-economic importance; (4) the species' range covers a major part of the Northeast inshore habitat; (5) comprehensive research programs on biological effects on the species are not being undertaken by others; and (6) significant information gaps exist for the species that are not likely to be filled without Center involvement.

Species recommended for current biological effects studies, based on the above criteria, are winter flounder, hard clam, American lobster, American oyster, and soft shell clam. Species for future studies (including anadromous fish, endangered species, and food chain organisms) will be selected based on information needs then considered most important, according to the above criteria.

Geographic areas for study should be selected based on any or all of the following criteria: (1) the assumed importance of the area to living marine resources of greatest concern to NMFS; (2) the presence of habitat types (e.g., salt marsh, intertidal mudflat, submerged aquatic vegetation beds) for which the Region has the most critical need for information regarding their functional value; (3) the presence of relatively clean, unmodified habitats in the area, and the likelihood that human activities will significantly alter these habitats in the near future; (4) the presence of degraded habitats that are amenable to long-term biological effects and ecosystem recovery studies; (4) the degree to which the area has been studied previously, and the likelihood that EPA, FWS, Sea Grant, the states, or others will conduct the needed research there in the near future; (5) the existence of relevant, good quality, accessible data and information for the area; (6) the proximity of the area to NMFS laboratories, the availability of suitable equipment and trained personnel, and the cost-effectiveness of the proposed studies; and (7) the likelihood that Center research efforts will contribute to solving resource management problems.

The Center is already conducting studies in several inshore areas (Table 1). Additional studies may be conducted in these same general areas, or in other areas based on the above criteria.

Biological effects studies should be conducted using the following guidelines:

1. Focus on relationship of laboratory experiments to in-situ field observations, especially macrocosm/mesocosm/microcosm studies and exposures to multiple stress.

2. Choose experimental study sites where impacts of habitat degradation are known, suspected of being most extreme, or seem inevitable, and where long-term effects can be assessed.

3. Where possible, study gradients of degradation or use multi-factorial designs to assess the relative significance of physical or chemical factors (e.g., study the synergistic effects of multiple contaminants), derive response rates, and identify the relative contribution of the factors to observed effects.

4. Study an adequate number of representative sites, stations, and samples to permit meaningful comparisons and analyses.

5. Work cooperatively with states, other NOAA components, and other federal agencies, where appropriate.

6. Develop research plans after available information is synthesized, and information gaps and research needs are clearly identified.

7. Undertake biological studies of individual sources of habitat degradation with methods to examine cumulative effects in mind, so that experimental designs and data analyses for the individual biological effects studies will provide appropriate information for examination of cumulative effects.

3.1 Effects of Contaminants

Human activities and the wastes associated with these activities contribute many different contaminants to inshore waters. These contaminants include potentially toxic chemicals, as well as nutrients and pathogens.

Although many of the chemical contaminants occur naturally, human activities alter the rates and amounts of these materials cycling in inshore environments to such a profound extent that potentially harmful levels are often reached in marine organisms and their habitats in Northeast inshore waters. Other chemicals, such as synthetic organic compounds, are, by definition, present in the environment only because they are produced by the chemical industry and released into the environment through human activities.

Contaminants may affect population dynamics of living marine resources in two ways: (1) directly, by causing an increase in mortality during one or more life stages, changing spawning or migrational behavior patterns, or changing the genetic fitness of the population; or (2) indirectly, by reducing the available habitat, or by causing bans on fishing and on consumption of fishery products to protect human health. Events that may cause organisms to avoid normally preferred habitats include (1) hypoxia or anoxia caused by nutrient overenrichment, (2) chronic poisoning brought about by industrial and municipal discharges, and (3) urban and agricultural runoff and its effects on (1) and (2).

To what extent and in what manner these events may affect the biological processes of inshore-dependent fishery resources and endangered species is a subject of major concern to recreational and commercial fishermen, seafood consumers, conservationists, government workers, and others whose livelihood depends on the sea, who use or otherwise enjoy the inshore environment and its living resources, or who are responsible for pollutant discharge regulation, fishery management, habitat conservation, and recovery programs for endangered species.

The anthropogenic additions of halogenated organic compounds, petroleum hydrocarbons, heavy metals, nutrients, and pathogens to inshore waters can cause problems by threatening ecosystems or contaminating sea food. Metals and organics are potentially toxic to marine organisms, and to humans when these chemicals are bioaccumulated in fishery products. Many of the contaminants (e.g., polychlorinated biphenyls, dioxins, and organotins) are persistent in the environment, and are toxic to marine organisms and humans at extremely low concentrations; i.e., at parts per billion to

parts per million levels. Other contaminants (e.g., cadmium) may be toxic not only by themselves, but may become more or less toxic in the presence of other metals (e.g., copper, iron, manganese) or organic carbon.

Nutrient overenrichment can cause shifts within the biological community to less desirable species, and can stimulate nuisance growths of algae and cause oxygen depletion when these growths decay, frequently resulting in mortalities of fish and other biota.

Pathogens and diseases introduced from municipal outfalls, land drainage, and other sources can increase rates of morbidity in marine organisms, and create public health problems as well.

The degree to which an organism is contaminated by a toxic substance depends on the concentration of the contaminant in the environment, the form of the contaminant, the length of time the organism is exposed to the contaminant, the level and source of exposure (water, sediments, or food), which part of the organism accumulates the contaminant, and the rate at which the organism can purge the contaminant from its system. If the source is water or sediments, the normal movements, distribution, and habits of the organism need to be fully understood; if the source is its food, the trophic dynamics of the system need to be studied, including the rate and total amount of bioaccumulation of toxic substances as they pass through the food chain.

Migrating fish and shellfish (e.g., lobster), and shellfish transplants, may play an important role in the dispersal of contaminants from an estuary, or in the introduction of contaminants to an estuary. This phenomenon can only be assessed through knowledge of migratory behavior and the factors that affect it, as well as the impact of emigration/immigration on the bioenergetics of the estuarine system. Migrations and shellfish transplants may also result in transfer of infectious disease agents (pathogens) among inshore and offshore waters.

FED's Experimental Biology Branch will be the lead Center unit for studies on the effects of toxic chemicals. Contributing Center units include EPD's Chemical Processes Branch and Environmental Analysis Branch (fates of toxic chemicals in coastal ecosystems), CUD's Population Dynamics Branch (collection of samples, analyses of growth and maturation effects), FED's Ecosystems Dynamics Branch (recruitment effects) and Pathobiology Branch (relationship of toxic chemicals to pathogens and disease), and RPAC (consultation on toxic chemicals to be studied, major problem

areas and issues, and coordination of efforts to evaluate alternative strategies).

EPD's Chemical Processes Branch will be the lead Center unit for the nutrient overenrichment biological effects studies. Contributing Center units include EPD's Physical Oceanography Branch and Environmental Analysis Branch (identification of potential areas of anoxia, biological effects), and CUD's Population Dynamics Branch (population and fishery effects) and Population Biology Branch (resource surveys).

FED's Pathobiology Branch is responsible for studies on effects of pathogens, and disease, including pathogen life cycles, and will be the lead Center unit for this component of the Framework. Assistance will be provided by CUD's Population Biology Branch (collection of samples) and Population Dynamics Branch (population and fishery effects).

Other NOAA/NMFS participants are expected to be the Region's Habitat Conservation Branch (interagency coordination, consultation on priorities of toxic chemicals, major contaminant problem areas and issues, strategies for mitigating adverse impacts, and product development), NMFS Headquarters (consultation on product development, coordination with headquarters of other NOAA elements), other NMFS Regions and Centers (consultation on fates and effects of contaminants, peer review and product development), NOS's OAD (identification of sources, levels, and fates of toxic chemicals, nutrients, and pathogens in coastal waters and sediments; identification of environmental factors associated with pathogen occurrence and disease outbreaks), and Sea Grant (cooperative studies).

Significant participation is also expected from FWS and the National Cancer Institute (NCI; cooperative studies), the Food and Drug Administration (FDA; assistance in analyzing tissue samples, regional surveys of pathogen occurrence and disease outbreaks), EPA (identification of contaminant sources, cooperative studies of effects, and assessment of alternative strategies for clean-up), state agencies (cooperative studies, assistance in survey design and sample collection), the academic sector (cooperative studies), and the private sector (participation in regional surveys, contracts for sample processing). Many of these entities will participate in peer review and product development.

3.1.1 Effects of Toxic Chemicals

The goal of the studies on biological effects of toxic chemicals is to relate concentrations in the inshore environment to effects on living resources.

The objectives for achieving the goal are to: (1) define the pathways and rates of uptake from food, water, and sediments, and the fates of toxic chemicals and metabolites within target organisms (i.e., determine exposure, uptake, and retention); (2) determine direct and indirect biological effects on target species; (3) create a relational data base and software, and prepare data for IDIMS; and (4) evaluate alternative strategies for mitigating adverse effects on living marine resources.

To accomplish these objectives, the Center needs to: (1) rank classes of toxic chemicals to be studied and determine the order of priority of contaminants within each class, based on cooperatively developed, agreed-upon criteria (e.g., toxicity, persistence, bioavailability, bioaccumulation); (2) choose representative study sites and target species; (3) summarize and evaluate existing knowledge; (4) determine research required to fill gaps in knowledge; (5) conduct a regional survey of levels of toxic chemicals and associated gross abnormalities in tissues of target species; and (6) design and conduct appropriate field and laboratory studies.

Direct and indirect effects that need to be addressed include effects on: physiology (cellular level--micro-biology, genetics); reproduction (gonadal development, fertility, maturation rate, egg viability); development (embryology, metamorphosis, etc.); subsequent generations (i.e., filial effects); behavior, feeding, growth, morbidity, and mortality; susceptibility to pathogens and disease; cumulative and synergistic effects of more than one chemical; recovery rates of degraded areas following clean-up or cessation of dumping or discharge. (Priorities must be established, and detailed plans must be developed for those effects actually chosen for study.)

Anticipated products from the toxic chemical studies include:

- Ranking of priority chemicals to study.
- Summaries and evaluations of available information.
- Research plans to fill gaps in knowledge and address priority issues.

- Distribution of body burdens of toxic materials in key organisms on a regional scale.

- Relationships of concentrations of chemicals in environment to concentrations in organisms.

- Fates and effects of toxic chemicals in target organisms (i.e., exposure, uptake, and retention).

- Relationship of disease and other abnormalities to toxic chemical concentrations in environment and organisms.

- Mortality rates due to individual toxic chemicals, as well as combinations of chemicals, for use in studies of cumulative effects of habitat degradation and fishing.

- Relational data base on toxic chemicals.

- Input to cumulative effects studies and to IDIMS.

- Evaluations of alternative management schemes to stop pollution or remove contaminants, including risk assessments and recommendations for remedial action.

3.1.2 Effects of Nutrient Overenrichment

The goal of the nutrient overenrichment studies is to determine organism- and community-level responses to changes in inshore systems due to events associated with excessive nutrient input to inshore waters (e.g., eutrophication, hypoxia, or anoxia, increased turbidity, and altered plankton species composition).

The objectives associated with this goal are to: (1) define the scope of the nutrient overenrichment problem for selected species, by geographic region; (2) determine effects of the events associated with nutrient overenrichment on species distribution, movement, and migration; (3) determine changes in feeding relative to impacts of the events on food supply; (4) determine effects of the events on reproduction and recruitment; (5) identify physiological and developmental effects (e.g., on growth); (6) determine the relationship of nutrient overenrichment to susceptibility of species to disease; (7) create a relational data base and prepare data for IDIMS; and (8) determine probable mechanisms for effects from the events, and evaluate alternative strategies for mitigating the events.

Anticipated products of nutrient overenrichment studies include:

- o A description of the regional extent and severity of existing and potential biological problems associated with nutrient overenrichment.
- o Summaries of existing knowledge of effects and mechanisms for effects.
- o Research plans for studies to fill gaps in knowledge and address priority issues.
- o Mortality rates due to effects of nutrient overenrichment for use in studies of cumulative effects of habitat degradation and fishing.
- o Species' threshold levels for dissolved oxygen.
- o Relationship of dissolved oxygen levels to species productivity.
- o Relationship of disease and abnormalities to various nutrient levels and concomitant eutrophication and hypoxia.
- o Relational data base and software package.
- o Input to cumulative effects studies and to IDIMS.
- o Evaluations of alternative management strategies for improving nutrient enrichment conditions, including risk assessments and recommendations for remedial action.

3.1.3 Effects of Pathogens and Disease

The goal of the studies on pathogens and disease is to determine relationship among disease outbreaks, presence of pathogens, and habitat degradation.

The objectives necessary to achieve this goal are to: (1) define the spatial and temporal occurrence of disease outbreaks in inshore waters; (2) identify habitat conditions that favor pathogens productivity and movement; (3) identify intermediate hosts (life cycles) for pathogens; (4) identify ranges and transport media for pathogens; (5) determine effects of disease on survival, growth, and reproduction at organism- and population levels; (6) establish association with other types of organism stress (contaminants, nutrient overenrichment, habitat loss); (7) create a relational data

base and software, and prepare data for IDIMS; and (8) evaluate alternative management measures to limit the spread of pathogens and outbreak of disease.

Anticipated products of the studies on pathogens and disease include:

- Spatial and temporal occurrence of disease outbreaks on a regional scale.
- Summaries of available information on life cycles (including intermediate hosts) of the most common pathogens, habitat conditions favoring pathogens, and pathogen ranges and transport media.
- Research plans to fill gaps in knowledge and address priority issues.
- Relationship of pathogen occurrence to other sources of organism stress.
- Mortality rates due to disease for use in studies of cumulative effects of habitat degradation and fishing.
- Relational data base and software package.
- Recommendations for disease prevention and control strategies.

3.2 Effects of Physical Habitat Alteration

The goal of the physical habitat alteration studies is to relate trends in the amount and condition of inshore habitat types to effects on inshore and offshore populations of living marine resources.

The major objectives of this component of the Framework are to: (1) obtain reliable information on the current availability (quantity and quality) of various habitat types and the rates of loss or gain; (2) determine species usage and importance (functional value) of individual habitats to total populations (inshore and offshore); (3) determine the similarity and comparability of habitats and habitat functional values along the Atlantic coast, and the extent to which research results can be extrapolated from one area to another; (4) determine the reaction of organisms to inshore habitat denial (behavior, density-dependent effects on survival, ability to locate and use alternative sites, etc.); (5) evaluate existing non-monetary assessment techniques for natural and artificial habitats, and adapt them to inshore

areas or develop additional techniques for inshore habitats, as necessary; (6) create a relational data base and software, and prepare data for IDIMS; and (7) evaluate various habitat mitigation/enhancement techniques for ameliorating habitat loss.

Resource and habitat managers need quantitative cause-and-effect information that defines, to the extent possible, the relationship between inshore habitat alteration and productivity of inshore-dependent populations. Understanding this relationship requires knowledge of each species habitat requirements and its ability to adapt to changes in its habitat. (This knowledge will be developed by studies on habitat requirements and use.)

Dredging, wetland filling, bulkheading, and dam construction are human activities that obviously result in physical habitat alteration or loss. The total amount of habitat proposed for alteration each year in the Northeast is relatively small (e.g., compared with the Southeast): In FY86, for example, NMFS reviewed about 1,833 applications from individuals, private businesses, and state and federal agencies for COE permits for dredging, filling, and impounding a total of about 5,866 acres of habitat; only about 6 acres of marine habitat were lost in FY86 because NMFS recommendations were not included in 16 permits issued over NMFS objections. Although this loss seems small, and perhaps insignificant, it is important to keep in mind that most of the natural inshore habitat along the Northeast coast has already been altered or lost, less suitable habitat remains in the Northeast each year to support living marine resource populations (despite the existence of fairly effective state and federal regulatory programs to protect wetlands), population pressure along the Northeast coast is increasing, and the cumulative effects of habitat alteration and loss on living marine resource populations are generally not known.

NMFS's ability to assess and predict the long-term effects of habitat alteration depends on knowledge of how habitats function, and on quantitative information on the extent and effects of habitat alteration and loss. These needs can be satisfied only by evaluating the functional relations between organisms and their habitats, and by determining the present status and rates of change of various inshore habitat types.

Much effort has gone into attempting to develop mitigation and enhancement approaches to ameliorate habitat loss through the COE's regulatory program for proposed construction and dredge-and-fill activities in coastal and inland waters. However, the degree to, and rate at which,

economically and ecologically valuable functions of lost habitat are replaced is poorly documented, and information on the processes that lead to successful replacement or enhancement is generally lacking. This knowledge is needed for effective management of habitats through the COE's regulatory program.

FED's Ecosystem Dynamics Branch will take the Center lead for studies on the functional value of habitats, comparability of habitat functional values, and evaluation of alternative mitigation and enhancement techniques. EPD's Environmental Assessment Branch, FED's Manned Undersea Research and Fisheries Engineering Branch (MURFE) and Experimental Biology Branch, and CUD's Population Biology Branch will conduct studies on the reaction of organisms to habitat availability; conduct studies on habitat usage, importance, and denial; and contribute to studies on habitat functional value and evaluations of alternative mitigation and enhancement techniques. CUD's Fisheries Statistics Branch will perform economic analyses. RPAC will help develop and monitor contracts for evaluating mitigation and enhancement techniques, participate in product development, and help coordinate research with cooperating agencies.

The Center will rely on the Region's Habitat Conservation Branch to: (1) collect, archive, and analyze data on habitat availability and rates of loss; (2) provide advice on habitat types and areas of most importance for study; (3) participate in field studies and ground-truthing activities; (4) provide liaison with other agencies regarding habitat-altering projects; (5) provide advice on non-monetary valuation, habitat evaluation procedures, and mitigation and enhancement techniques; and (6) participate in peer review and product development. The Center also will rely on NMFS Headquarters for help in coordinating with other NOAA elements, and for advice on product development.

The Center will rely on the Southeast Fisheries Center and Southeast Region, especially during the early stages of these studies, for: (1) cooperative studies and assistance in study design, collection of samples, and data analysis and interpretation; (2) consultation on habitat availability and functional values, comparability of habitats and functional values, non-monetary habitat evaluation techniques, and product development; and (3) peer reviews.

The Center will rely on other NOAA elements (e.g., OAD, EPO, and Sea Grant) and other federal agencies (e.g., FWS, COE, and EPA) for cooperative studies, consultation on habitat status and trends, habitat evaluation procedures, mitigation and enhancement techniques, and participation in peer review and product development; state agencies for

cooperative studies, consultation on availability of habitat types, habitat usage; the academic sector (e.g., the NEARSS Association) for information on habitat status and trends; and the private sector through contracts for mitigation and enhancement studies.

Products anticipated from the physical habitat alteration component of the program include:

- Status and trends in quantity and quality of inshore habitats.
- Functional (ecological) valuation of inshore habitats.
- Comparison of the functional values of habitat types along the Atlantic coast.
- Assessment and modification of habitat evaluation procedures.
- Relative impacts of loss of habitat types on fishery stocks and endangered species in presently used and potential alternative areas.
- Mortality rates due to physical habitat alteration and loss for use in studies on the cumulative effects of habitat degradation and fishing.
- Relational data base and software.
- Input to habitat requirements and use studies, cumulative effects studies, and IDIMS.
- Recommendations for mitigation/enhancement techniques.

3.3 Cumulative Effects of Habitat Degradation and Fishing Mortality

The goal of the cumulative effects studies is to evaluate, develop, and use conceptual approaches (models) for linking effects on organisms caused by habitat degradation to effects on populations and fisheries yields.

The objectives associated with these studies are to: (1) evaluate available conceptual approaches, and develop and implement new approaches, as necessary; (2) use models to determine the types of information needed from biological effects studies; (3) use models to assess and predict cumulative effects; (4) partition levels of natural and

anthropogenic mortality; (5) create a relational data base and software, and prepare data for IDIMS; and (6) link findings (products) to research planning.

Existing tested and evaluated models will be used first, and any new models that are developed will be tested, modified, and verified to ensure that they adequately reflect the system chosen for modeling.

The biomass of a population can be characterized as a balance between gains realized through growth and recruitment, and losses from several types of "competing" mortalities. These mortalities include natural mortality from predation or disease and anthropogenic mortality from fishing, pollution, and habitat alteration and loss. Stock assessment research attempts to partition and determine the levels of each of these mortalities, and to examine the effects of each on population levels, anticipating that different mortalities affect distinct life history stages of the individuals in a population. For instance, predation mortality may primarily affect early life history stages (eggs, larvae, juveniles) because potential predators of smaller individuals are more numerous. In contrast, fishing mortality is concentrated on adults, and sometimes juveniles, of most exploited species. Pollutant-related stresses may affect population levels by reducing fecundity or the viability of the ova; by decreasing the survival of larvae, postlarvae, and juveniles; and by increasing mortalities on the recruited population by increasing the incidence of disease and vulnerability to predation.

Additional comprehensive studies need to be conducted to determine the long-term, cumulative effects of habitat degradation and fishing on (1) populations of inshore-dependent living resources (including changes in habitat or biomass of prey organisms) and (2) catches of recreational and commercial fish. These studies will involve evaluating and utilizing various conceptual approaches (models) to evaluate the population- and fishery-level effects of competing mortalities, and to partition the levels of mortality from natural and anthropogenic causes.

Complex inshore ecosystems include living marine resources from microorganisms to apex predators, all under the influence of their habitat. Models are used to integrate various hypotheses about the functioning of an ecosystem, assure that research hypotheses are internally consistent and are focused on the problems at hand, test whether or not they are contradicted by available information, determine the relative importance of various processes and controlling factors, determine the types of data needed, and make predictions.

Existing fisheries models can be used as a starting point to develop new models to assess the effects of anthropogenic stress and natural factors on important inshore fishery resources. These models need to be evaluated and modified as appropriate, and sub-models need to be built. To implement this approach, a substantial body of traditional fisheries data is required to estimate catch, growth, mortality, recruitment, and reproductive parameters. This information presently exists for only a few populations.

Available information needs to be surveyed, including existing habitat types and trends, levels of toxic chemicals, and environmental factors (temperature, salinity, oxygen, substrate composition, etc.). Hypotheses need to be developed, refined as necessary, and tested in controlled experiments (e.g., mesocosms) and, ultimately, at various representative sites in the field. This approach provides a framework that should make it possible to quantify the effects of fishing and habitat degradation in a "common currency," whereby the effect of a particular type of habitat degradation (or several types together) can be expressed in terms of the equivalent stress on a population in units of fishing mortality or loss in fishery yield.

FED's Ecosystems Dynamics Branch and CUD's Population Dynamics Branch will share the lead for developing and executing population and community models, and for identifying additional data needs. Contributing Center units include all Branches presently or potentially involved in studies on the biological effects of contaminants, nutrient overenrichment, pathogens and disease, and physical habitat alteration. Assistance in developing models also is expected to come from Sea Grant, FWS, state resource management agencies, and the academic sector.

Anticipated cumulative effects studies products include:

- Methodologies for determining cumulative effects.
- Relative importance to populations and fisheries of sources of mortality due to habitat degradation and fishing.
- Mortality rates due to the combined effects of toxic chemicals, nutrient overenrichment, pathogens and disease, and physical habitat alteration.
- Additional data collection needs for habitat degradation studies.
- Assessments and predictions of cumulative effects.

- o Relative importance of sources of mortality by species and habitat type.

- o Risk assessments and recommendations.

4.0 Fishery Statistics and Stock Assessments

The goal of this component of the Framework is to determine the contribution of inshore biological processes to total fisheries yield potential.

The major objectives associated with this goal are to: (1) improve the accuracy, completeness, and timeliness of commercial and recreational harvest statistics for inshore waters; (2) participate in, and contribute to, joint Center/State assessments of fishery stocks of regional importance and of endangered species found in inshore habitats; (3) determine the relationship between the inshore and offshore abundance and yield of selected species; (4) determine the origin of stocks contributing to fisheries in inshore and offshore areas; (5) determine the long-term implications of inshore fishing mortalities to recreational and commercial fisheries; and (6) create a relational data base for inshore fisheries statistics and stock assessment data, and input relevant data to IDIMS and other inshore studies.

Better documentation of the characteristics of inshore fisheries, particularly the recreational fisheries, is necessary to support fishery management and habitat conservation objectives throughout the range of each species. Fisheries statistical information should be improved to document the importance of inshore areas, and to support analyses of mortalities and the effects of fishing on inshore fish stocks.

Catch, effort, and economic data need to be collected and analyzed more quickly and accurately for all major recreational and commercial species in inshore areas. A fisheries network among NMFS, the Fishery Management Councils, and the coastal states needs to be developed and maintained. Ongoing cooperative efforts with the states to collect better statistics on inshore fisheries need to be accelerated and expanded, especially for the recreational fisheries.

Stock assessments are regularly performed for several species exploited in both inshore and offshore waters. Stock assessment workshops that consider inshore fish populations are now conducted each fall by the Center, with state and

academia participation. Recommendations are carried forward immediately to the ASMFC.

To determine the long-term implications of anthropogenic mortalities on inshore stocks to recreational and commercial fishing, additional research is needed on the relationship between effective fishing effort and the fishing mortality generated on multispecies assemblages and component species in fisheries conducted in inshore waters, and on endangered species that frequent inshore waters (e.g., shortnose sturgeon and Kemp's ridley sea turtle).

Stock assessments for species subjected to inshore fisheries should include information on: (1) present status of stocks in relation to historical record; (2) evidence for trends in status of stock abundance or catch; (3) evaluation of proposed or existing management regulations; (4) effects of habitat degradation on status of stocks and fisheries; (5) short-term and long-term projections for status of stocks; (6) plans for surveillance and monitoring programs, and for special research projects; and (7) special assessments on marine mammals and endangered species.

Combined fishery-independent resource survey data from each of the state and federal surveys conducted in inshore waters need to be analyzed and evaluated to determine abundance levels, distribution patterns, migration or movement patterns, and residence times of the species. In some areas, inshore surveys must be expanded or created to provide the information needed.

Given the uncertainties involved with the adequacy of the available catch and effort data for inshore species, survey indices play an important role in the analysis of trends in abundance of these species. Statistical methods (time series models, etc.) for combining and analyzing the data must be determined or developed before the combined survey data will be applicable to assessment activities.

Many inshore-dependent fish species migrate and are caught away from home waters; therefore, controlling fishing to ensure optimum utilization of a fishery resource requires an understanding of the origin of the stocks contributing to that fishery, knowledge of the inshore waters from which the stocks originate, and knowledge of the migratory patterns of the species. It is also important to know the geographic range and the extent to which an inshore-dependent stock contributes to coastal fisheries, so that risk of exposure to humans can be assessed if that stock is contaminated with toxic compounds. EPA and the states are particularly interested in using this information to set water-, air-, and land-use standards.

Current information on several species (e.g., winter flounder) considers all stocks together in the fisheries. Separate stocks or subpopulations should be identified, using standard methodologies (suitably modified for inshore areas and species, if necessary), before attempting to determine the effects of fishing on offshore aggregations of fish that utilize inshore waters during certain periods of their lives. Methods available include tagging studies, multivariate statistical analyses of meristics and morphometrics, image analysis of scales and otoliths, electrophoresis and isoelectric focusing, and monoclonal antibodies.

Products anticipated from these efforts include:

- Designs for collecting fisheries statistics usable by NMFS and/or states, emphasizing comparability and quality assurance of all data used in stock assessments.
- Fisheries statistics networking system.
- Assessments of inshore fishery stocks and endangered species of national or regional importance.
- Plans for surveillance and monitoring programs and special research projects.
- Relational data base and software package.
- Input to habitat requirements and use studies and to IDIMS.
- Comparison of the relative abundance of species in inshore and offshore areas.
- Comparison of recreational fish catches and value (e.g., expenditures by fishermen) in inshore and offshore areas.
- Comparison of commercial fish landings and value of fish caught in inshore and offshore areas, and distinction between sources of fish harvested.
- Identification of stocks or subpopulations inhabiting or harvested in inshore and offshore areas.
- Comparative effects of fishing mortality on inshore and offshore stocks and fisheries.

In cooperation with state fish and wildlife agencies, FWS, academic institutions, NMFS Headquarters, and fishermen, the Center (CUD) collects and archives recreational and commercial fishery statistics information (Fishery Statistics and Economics Branch), organizes and participates in stock assessment workshops (Population Dynamics Branch), and monitors inshore and offshore stocks (Population Biology Branch). These three Branches will share the Center lead for accomplishing the objectives of this component of the Framework, and will coordinate with other Center elements as necessary. The Center will rely on the Region's State Federal Relations Branch to monitor grants to states for collection of fisheries statistics and stock monitoring information.

C. COORDINATION OF THE CENTER'S INSHORE RESEARCH INSIDE AND OUTSIDE NOAA

Coordination of information exchange is an important part of the Center's inshore research program, and may in fact be the key to its ultimate success. The Center must interact with many other agencies and institutions interested in the condition of inshore living resources and their habitats. The scientific purpose of these interactions is three-fold: (1) to obtain baseline information on historical and projected trends in habitat degradation; (2) to participate in collaborative studies; and (3) to provide other agencies and institutions with scientific knowledge necessary for successfully conducting their research programs.

Formal interactions to date have been with NMFS's Northeast Regional Office, NMFS Headquarters, other NMFS Regional Offices and Fisheries Centers, other NOAA components (e.g., EPO, OAD, Sea Grant), other federal agencies (e.g., EPA, COE, FDA, NCI), the National Science Foundation and National Academy of Sciences, the coastal states (in stock assessment workshops, etc.), and academia (e.g., the NEARSS Association). Data and information transfer activities related to inshore research are also conducted informally on a scientist-to-scientist level, as well as on a national and international level.

An overriding problem facing the Center in coordinating its inshore research activities is the necessity to provide information for use within the management and research structure of other agencies, specifically EPA, that are not based on a regional perspective. Although only 7 percent of the Center's inshore research is supported by EPA in FY87, Center scientists have to deal with separate, often

independent management and research entities for each of the four estuaries presently in EPA's program in the Northeast (i.e., Long Island Sound, Buzzards Bay, Narragansett Bay, and Chesapeake Bay). Each estuary has a Management Committee, a Technical Advisory Committee, a Citizens Advisory Committee, and sundry working groups. The Water Quality Act of 1987 adds New York-New Jersey Harbor and Delaware Bay to the National Estuary Program, and directs EPA to assess the principal factors adversely affecting environmental quality in Boston Harbor and to develop and implement a management program to improve the water quality of Boston Harbor and adjacent areas. The Center will be expected to take advantage of these additional opportunities for interagency research planning and coordination.

Many of the Center's interactions with other federal agencies are initiated through the Region in conjunction with reviews of federally authorized projects that pose significant environmental impacts. These reviews usually involve helping the Region summarize available information, rather than conducting research. The Region will continue to handle most such information summaries, in consultation with Center scientists as necessary, and will continue to maintain liaison with the states, other federal agencies, and Fishery Management Councils on habitat-altering projects that may affect inshore living marine resources.

The primary benefit of these many interactions with other agencies and institutions is <u>cost effectiveness</u>: Cooperative studies maximize the use of the federal dollar by avoiding redundancy in data collection and research programs, especially among federal agencies. The Center will pursue cooperative efforts to the maximum extent possible to achieve the most efficient and effective use of human and fiscal resources.

III. IMPLEMENTATION OF THE INSHORE RESEARCH PROGRAM

A. IMPLEMENTATION OPTIONS

The level of involvement of the Center in research activities associated with inshore living resources in FY88 and beyond could follow one of three possible options: (1) reduce or eliminate involvement in inshore research in favor of expanding research activities dealing with offshore living resources; (2) maintain the current level of inshore research, and consider reprogramming some inshore research activities; or (3) expand the current level of inshore research, through (a) reprogramming, (b) seeking reimbursables, or (c) submitting budget initiatives.

Option 1 (reduce or eliminate involvement) is not a good choice due to the present desires of Congress and NOAA for NMFS to participate more fully in intra- and interagency inshore research programs, such as the National Estuary Program and the Status and Trends Program.

Adopting Option 2 (maintain current level of involvement) would lead to development of some of the products listed in the Framework, but would not encourage a well-integrated, long-term approach to inshore research that has consistency in terms of priorities, relationships among projects, satisfaction of information needs, and timeliness of products.

The Center does not have the base funds necessary to expand its inshore research efforts by reprogramming from other research areas (Option 3a). Reprogramming would reduce to an unacceptable level the Center's capabilities to respond to MFCMA and related offshore information needs. Since these needs are expected to grow, further reprogramming to enhance inshore research is not a realistic option.

Additional reimbursables could be sought from other agencies, such as EPA and COE, to expand the Center's inshore research program (Option 3b). Coordination and cooperation among federal agency line offices is desired, but the one-year reimbursable mode creates difficulties in Center planning and management of the projects. These difficulties are particularly apparent when several agency reimbursables are involved. Because longer-term transfer of funds is currently not the policy, reimbursables are not suitable to support the long-term Center commitment that is required. Furthermore, products from reimbursed projects may suit the funding agencies and perhaps satisfy other needs, but may be unsuitable for developing and enhancing the inshore data and information base that is the backbone of the Center's inshore

research program. Therefore, the option for a Center base-funded program would better serve to achieve the objectives of the Framework, including promoting regional cooperation.

Once the program is fully implemented, reimbursables should only be accepted for "packaging" information on inshore living resources in a product form requested by the funding agency. The design, collection, and analysis of information related to inshore living resources under the purview of NMFS should be conducted by Center scientists under base-funded projects; in this way, the Center can maintain full management control over its long-term information base, and provide stable funding to develop top quality professional staff.

Finally, under Option 3c, the Center could seek additional base-level funding through a budget initiative (or initiatives). The initiative could include any or all parts of the Framework. Within the initiative, it would be important to identify products for each year's activities, and to relate these products to the objectives established for each research area in the Framework. The initiative should also provide allowance for additional support ceiling.

B. IMPLEMENTATION SCHEDULE

Activities necessary to accomplish the objectives of each of the Framework's components will be conducted in several "phases" (Table 2). The duration of any one phase could be weeks to years, depending on such variables as the availability of funds and personnel, the duration of the sampling program, and the availability of information required from other studies within the program and from outside sources.

The status of knowledge relative to certain components of the Framework (e.g., Effects of Toxic Chemicals) is more advanced than for other components (e.g., Effects of Physical Habitat Alteration and Loss). Thus, some of the steps depicted in Figure 2 and Table 2 may already be accomplished or underway, whereas work must begin at the basic stage of information assembly and evaluation for other components.

Although the phases for any one component are sequential, the phases may also be interrelated among components. For example, studies on Cumulative Effects of Habitat Degradation cannot begin until information is assembled from the studies dealing with the individual

Table 2. Major Research Activities Included in the Framework for Inshore Research

AREA	PHASE I	PHASE II	PHASE III	PHASE IV	PHASE V
IDIMS	Obtain, evaluate, and summarize available information Design IDIMS Develop data base format Specify interim system to archive data and information	Procure hardware Develop software Develop tutorials	Begin loading data on system Make modifications and adjustments Develop interim products	Complete "user-friendly" system	Develop and disseminate integrated products Modify system, as necessary
HABITAT REQUIREMENTS	Select species Obtain, evaluate, and summarize available information Develop matrix of status of habitat requirements and use knowledge	Define habitat use, essential habitat areas, and requirements, based on available information Develop plans and conduct research to fill information gaps	Develop relational data base and software package Make input to IDIMS Make input to Physical Habitat Alteration and Loss research, and other projects Develop interim products	Develop maps, atlases, inventories, etc.	Develop and disseminate integrated products

Table 2 (Cont'd).

AREA	PHASE I	PHASE II	PHASE III	PHASE IV	PHASE V
TOXIC CHEMICALS	Obtain, evaluate, and summarize available information Develop research plan Choose study sites and target species Rank chemicals Conduct regional survey of concentration of contaminants in target species Summarize regional distribution of toxic chemicals Conduct biological effects studies	Continue biological effects studies Develop relational data base and software Develop summary of effects on reproduction, development, genetics, behavior, feeding, etc. Summarize exposure and retention in organisms	Make input to IDIMS Summarize relationship of contamination to concentrations in the environment Determine mortality rates Determine relationship of disease and abnormalities to toxic chemicals Make input to cumulative effects studies	Develop interim products	Develop and disseminate integrated products Evaluate alternative management strategies
NUTRIENTS	Obtain, evaluate, and summarize available information Survey scope of problem Develop research plan Conduct biological effects studies	Summarize biological effects on target species Develop relational data base and software Continue biological effects studies	Make input to IDIMS Make input to cumulative effects studies Determine mortality rates Continue biological effects studies	Develop interim products Determine relationship of nutrient enrichment to target species productivity and distribution	Develop and disseminate integrated products Evaluate alternative management strategies

Table 2 (Cont'd).

AREA	PHASE I	PHASE II	PHASE III	PHASE IV	PHASE V
PATHOGENS	Obtain, evaluate, and summarize available information Develop research plan Conduct biological effects studies	Summarize life cycles of pathogens Summarize conditions that favor disease outbreaks Develop relational data base and software Continue biological effects studies	Make input to IDIMS Make input to cumulative effects studies Determine mortality rates	Develop interim products Determine relationship of disease occurrence to other sources of organism stress	Develop and disseminate integrated products Evaluate alternative management strategies
PHYSICAL HABITAT ALTERATION AND LOSS	Obtain, evaluate, and summarize available information Specify product needs to NOAA/OAD	Summarize availability of habitat types and rates of gain or loss Develop valuation of habitat types for selected species	Integrate output from HABITAT REQUIREMENTS AND USE studies Develop research plan	Make input to IDIMS Conduct planned studies	Specify impacts of loss of habitat types on selected species Evaluate relative importance of sources of mortality by habitat type Make recommendations for mitigation and enhancement techniques

Table 2 (Cont'd).

AREA	PHASE I	PHASE II	PHASE III	PHASE IV	PHASE V
CUMULATIVE EFFECTS OF HABITAT DEGRADATION	Obtain, evaluate, and summarize available information Evaluate available methodologies and develop new ones, if necessary	Develop population modelling techniques	Evaluate and integrate output from other biological effects studies Make input to IDIMS	Develop research plans and begin cumulative effects studies Develop relational data base and software Develop interim products	Determine mortality rates Develop and disseminate integrated products
FISHERY STATISTICS AND STOCK ASSESSMENTS	Obtain, evaluate, and summarize available information Implement fishery statistics network Conduct biannual Stock Assessment Workshops Conduct studies on stock identification, surveys, and special studies	Conduct inshore species assessments Develop inshore - offshore relational software Continue biological studies	Make input to IDIMS Conduct inshore - offshore comparisons for selected species Continue biological studies	Develop interim products Continue biological studies	Develop and disseminate integrated products Continue biological studies

sources of habitat degradation (contaminants and physical habitat alteration and loss). As such, research required to achieve the Framework's objectives must be closely coordinated within and among the major components.

Implementation of the inshore research program will bring the inshore studies now underway into a more cohesive program for FY88 and beyond. Many of the objectives identified in the Framework are already being addressed at some level by Center scientists; however, the Framework provides a mechanism for tracking progress and assuring that the Center's inshore research is being directed toward clearly defined goals. Timelines for tasks and products will be developed in the early implementation phase of the program, as will the description of information flow from data gathering and analysis to final products.

A schedule for products will be determined by RPAC in consultation with the Center Division Chiefs, the Regional Office, and all other major user groups, especially the States, ASMFC, Fishery Management Councils, NMFS Headquarters, and NOAA/EPO.

C. PROGRAM PRIORITIES

1.0 New Projects

The top priority for implementing the inshore research program is completion of the tasks associated with creation and use of IDIMS. Development and implementation of IDIMS is key to the program's success. IDIMS is important to the entire RAP effort, and to more fully implementing NMFS's Habitat Conservation Policy in the Northeast.

IDIMS will link all areas of the Center's inshore research program by functioning as the mechanism by which data and information produced by the program are assembled, retrieved, and evaluated. Once IDIMS is operational, it will facilitate interactive analyses of inshore data and information, and development of integrated products such as maps, atlases, inventories, and characterizations. It will also provide information useful to scientists conducting studies under any particular program element, and RPAC and others involved in research planning, evaluation, and coordination.

Assembly, synthesis, and evaluation of information that defines inshore habitat requirements and use by important living marine resources will receive the next highest priority. Undertaking these tasks is a logical step in the evolution of the RAP process. The initial product of this effort, a matrix of the status of habitat-use knowledge, will be used to formulate a coastwide cooperative research program on the effects of habitat alteration, loss, and mitigation.

2.0 Ongoing Projects

Biological effects research and joint State/Center fisheries statistics collections and stock assessments are two research areas identified in the Framework where the Center already has significant ongoing involvement. FED has launched a "case study" on winter flounder in Northeast inshore waters; this study focuses on the population-level effects of contaminants. CUD has begun conducting stock assessment workshops on a biannual basis; scientists from the Center, states, and academia exchange information and jointly develop advice for fishery managers. The Center is also participating in a joint program with the states, under the auspices of the ASMFC, for a shared network of fisheries statistics data. It is important that these activities continue, with an emphasis on the population- and fishery-level effects of contaminants on the reproductive success of winter flounder and lobster.

D. RECOMMENDED ACTIONS

1. Prepare a Center budget initiative for FY89 that expands the capability of the Center and Region to address the objectives of the Framework for Inshore Research. The initiative should be for a five-year cycle, should identify products from each year's activities and relate them to the Framework's objectives, and should include allowances for changes based on short-term findings. The Center should use the initiative funding to build upon its current base level expenditures, rather than depend on the new monies to support the entire inshore research program.

2. Immediately begin to enhance the ongoing inshore research activities being conducted by the Center by drawing them into a more focused program. Other Divisions within the Center should align their activities, to the extent possible, with the winter flounder studies recently initiated by FED. Reimbursable funding should be used to help establish new areas of inshore research, summarize information to satisfy the needs of the Center's user groups, and complete inshore projects currently being undertaken that are beyond the scope

of the inshore research program. The in situ analysis of contaminant effects proposed by FED as part of the winter flounder case study, which requires start-up support for developing prototype study chambers and for evaluating potential study sites in the Northeast, is an example of the type of research project that should qualify for reimbursable funding.

3. Begin studies recommended in the Habitat Requirements and Use section of the Framework for Inshore Research as soon as possible. Habitat requirements and use information is a high priority need of the Region's Habitat Conservation Branch; this information is used during evaluation of habitat-altering projects, as well as for preparation of habitat sections of fishery management plans. The Center and the Region should begin the tasks necessary to achieve the objectives outlined in this section with internal funds if monies are not otherwise available.

4. Accelerate and expand cooperative efforts to develop and implement a fisheries statistics network with the states, and continue cooperative semi-annual stock assessment workshops. The Center's inshore research efforts should be directed toward determining: (a) the relationship between the inshore and offshore abundance and yield of winter flounder and lobster, (b) the origin of stocks contributing to fisheries in inshore and offshore areas, and (c) the long-term implications of inshore fishing mortality to recreational and commercial fisheries.

5. Develop operational approaches for accomplishing the Framework's objectives, with or without additional funding. The lead Center unit for each of the Framework's components should immediately begin to develop these approaches so that appropriate Center units can conduct the necessary inshore research. The operational plans should include contingencies for supporting the Center's inshore research efforts if the FY89 budget initiative is not funded, or is funded only partially or incrementally.

(continued from inside front cover)

39. ***USA Historical Catch Data, 1904-82, for Major Georges Bank Fisheries.*** By Anne M. T. Lange and Joan E. Palmer. May 1985. iii + 21 p., 12 figs., 2 tables. NTIS Access. No. PB85-233948/AS.

40. ***Indexing the Economic Health of the U.S. Fishing Industry's Harvesting Sector.*** By Virgil J. Norton, Morton M. Miller, and Elizabeth Kenney. May 1985. v + 42 p., 44 figs., 25 tables, 1 app. NTIS Access. No. PB85-217958/AS.

41. ***Calculation of Standing Stocks and Energetic Requirements of the Cetaceans of the Northeast United States Outer Continental Shelf.*** By Robert D. Kenney, Martin A. M. Hyman, and Howard E. Winn. May 1985. iv + 99 p., 1 fig., 5 tables, 1 app. NTIS Access. No. PB85-239937/AS.

42. ***Status of the Fishery Resources Off the Northeastern United States for 1985.*** By Conservation & Utilization Division, Northeast Fisheries Center. August 1985. iii + 137 p., 46 figs., 49 tables. NTIS Access. No. PB86-125473/AS.

43. ***Status of the Fishery Resources Off the Northeastern United States for 1986.*** By Conservation & Utilization Division, Northeast Fisheries Center. September 1986. iii + 130 p., 45 figs., 48 tables. NTIS Acces. No. PB87-122115/AS.

44. ***NOAA's Northeast Monitoring Program (NEMP): A Report on Progress of the First Five Years (1979-84) and a Plan for the Future.*** By Robert N. Reid, Merton C. Ingham, and John B. Pearce, eds., and Catherine E. Warsh (water quality), Robert N. Reid (sediments & bottom organisms), Adriana Y. Cantillo (trace contaminants in tissues), and Edith Gould (biological effects), topic coords. May 1987. xi + 138 p., 13 figs., 1 table, 9 app.

45. ***Food and Distribution of Juveniles of Seventeen Northwest Atlantic Fish Species, 1973-1976.*** By Ray E. Bowman, Thomas R. Azarovitz, Esther S. Howard, and Brian P. Hayden. May 1987. xi + 57 p., 10 figs., 19 tables.

46. ***Influence of Freshwater Inflows on Estuarine Productivity.*** By James G. Turek, Timothy E. Goodger, Thomas E. Bigford, and John S. Nichols. May 1987. iii + 26 p.

47. ***MARMAP Surveys of the Continental Shelf from Cape Hatteras, North Carolina, to Cape Sable, Nova Scotia (1977-1984). Atlas No. 2. Annual Distribution Patterns of Fish Larvae.*** By Wallace W. Morse, Michael P. Fahay, and Wallace G. Smith. May 1987. viii + 215 p., 27 figs., 2 tables.

48. ***Indexed Bibliography of the Bay Scallop*** **(Argopecten irradians).** By Barbara D. Sabo and Edwin W. Rhodes. May 1987. iii + 85 p.

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