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Quantifying Resource Loss through Habitat Degradation: Proceedings of the First NMFS Northeast Environmental Workshop, March 13-14, 1991, Gloucester, Massachusetts

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Gloucester, Massachusetts

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INTRODUCTION

In April 1990, the National Marine Fisheries Service's (NMFS) Northeast Region formed the NMFS Northeast Environmental Council ("Environmental Council"). One of the activities described in the Environmental Council's charter is to "conduct workshops on key habitat issues of regional concern." The first of these workshops was held during March 13-14, 1991, with a planned focus on the problem of quantifying living marine resource losses resulting from habitat degradation.

This document summarizes the workshop and does not constitute a comprehensive record of all discussions. It is composed of three primary sections: (1) "Synopsis of Presentations and Discussions"; (2) "Apparent Needs and Proposed Actions"; and (3) "Appendices" which contain most of the overheads and handouts at the workshop. The agenda for the workshop is Appendix A. The participants in the workshop are listed in Appendix B. Each participant was provided an issue paper (Appendix C) as background for the presentations and discussions.

SYNOPSIS OF PRESENTATIONS AND DISCUSSIONS

OVERVIEW

M. Ingham, Chair of the Environmental Council, introduced the members of the Council to the participants, presented the function and charter of the Council, and reviewed the status of the Council's first nine projects (Appendix D).

R. Roe, NMFS Northeast Regional Director, described the awakening of habitat/resource loss concerns in NMFS and in the regional fishery management councils. The Magnuson Fishery Conservation and Management Act ("Magnuson Act"), as amended in 1983, required that stronger habitat sections be written into fishery management plans (FMP), but left NMFS to function in a purely advisory capacity. Within those limitations, the NMFS Northeast Region: (1) developed a Northeast Environmental Policy (Appendices E and F); (2) worked with the regional fishery management councils to improve habitat sections of FMPs; (3) created the Environmental Council to interface and foster collaboration between the NMFS Northeast Regional Operations Office (management) and the NMFS Northeast Fisheries Science Center (research); and (4) established a workshop series on fishery habitat issues, modeled after the stock assessment workshops of the Northeast Fisheries Science Center.

The Magnuson Act, as amended in 1990, emphasizes the importance of habitat degradation and strengthens the regional fishery management councils' authority to comment on any activity proposed by any state or federal agency which may affect the habitat of a fishery resource under its jurisdiction. In specific, the amended Magnuson Act allows the regional fishery management councils to comment on activities that may affect fishery habitats, and requires them to comment on activities that "substantially affect the habitat of anadromous species under their jurisdiction." The amended Magnuson Act also specifies that any federal agency receiving written comments shall, within 45 days, provide a detailed response, including a description of measures being considered for mitigating or offsetting potential habitat effects. In this light, the NMFS Northeast Regional Director has directed the Environmental Council to develop a cooperative approach to quantifying resource loss through habitat degradation, and to increase interagency appreciation of the importance of fishery habitat as recognized by the amended Magnuson Act (Appendix G).

J. Pearce, Acting NMFS Northeast Science and Research Director, presented an overview of coastal pollution problems with a focus on the Northeast. The principal cause of U.S. coastal pollution is the relative growth of population and industry within the 50-mile coastal band. However, a considerable source of coastal pollution often can be transported from far inland by air and water, including non-point-source nitrogen and phosphorous from farmland and lawns. Pearce noted that traditional scientific approaches to coastal marine pollution problems have several shortcomings: (1) too narrow geographic and ecological perspective; (2) failure to consider existing data and information carefully before launching new field and laboratory studies; and (3) reporting results in language understood only by other scientists, thus failing to communicate with managers and regulators. In conclusion, Pearce forecast that continuing depletion of wild fish stocks will eventually shift society to mariculture to provide seafood, which is dependent upon clean waters and healthy estuaries. In meeting this requirement, considering the myriad multiple uses of the coastal zone, activities to protect and restore the Northeast's coastal waters need to grow through cooperation and commitment (Appendix H).

J. O'Reilly, ecologist with the Northeast Fisheries Science Center, described a nearly completed study of the natural recovery and restoration of the habitats and biota surrounding the 12-Mile (sewage sludge) Dumpsite after cessation of dumping at the New York Bight site. Early results at three stations (*i.e.*, polluted, slightly affected, and unaffected) show a gradual return to a species complex and to trace metal and carbon levels in surface sediments more representative of unaffected coastal sites. This convergence apparently is occurring for other variables also, but more slowly. The final results of the study will be reported at a symposium on "Changes in Habitats and Biota at the 12-Mile Dumpsite during and following Cessation of Sewage Sludge Disposal" on June 18 and 19, 1991, at Long Branch, New Jersey (Appendix I).

J. Paul, Program Manager for the near-coastal marine component of the U.S. Environmental Protection Agency's (EPA) Environmental Monitoring and Assessment Program (EMAP), described the nationwide EMAP, focusing

on the near-coastal marine component. EMAP is the manifestation of the new, broader ecological perspective in EPA, which expands the agency's historic human-health initiatives into toxicology. The first field sampling in the near-coastal component visited over 100 sites (mostly estuarine) in summer 1990 in the Northeast between Cape Cod and Cape Henry (*i.e.*, Virginian Province). Program plans call for resampling the Virginian Province and for initial sampling in the Gulf of Mexico (*i.e.*, Louisianian Province) in summer 1991. In each case, the initial focus of the near-coastal component is on estuaries, and will shift later to include nearshore ocean ecosystems. EMAP is designed to define existing ecological conditions, determine trends in conditions, provide a base for comparative risk assessments, develop better indicators of ecological health, and develop technologies for status and trends assessment. EMAP is an interagency, cooperative program with NOAA which is participating through the National Ocean Service's Status and Trends Program (Appendix J).

P. Hughes of the Massachusetts Office of Coastal Zone Management described an interstate (*i.e.*, Massachusetts, New Hampshire, and Maine) and international [*i.e.*, United States and Canada (*i.e.*, New Brunswick and Nova Scotia)] research, monitoring; management, and education effort in the Gulf of Maine region. The cooperative initiative recognizes the value of the Gulf of Maine's living resources and the human activities conducted in or near it, but also addresses human threats to the Gulf of Maine's ecosystem. Ecosystem stresses are evidenced around the gulf, but more data must be collected to evaluate trends in environmental quality. The cooperative effort hopes to lead to management of the environmental quality in the Gulf of Maine by understanding the principal stresses and effects tending to reduce the quality and value of the gulf's ecosystem (Appendix K).

T. Bigford, Chief of the Northeast Regional Operations Office's Habitat and Protected Resources Division, described the information needs of Northeast Region habitat and resource management programs. These needs arise from both site-specific and broad-extent problems. Habitat managers are shifting their focus from primarily individual site-specific problems to a more effective mix, including broad-based, recurring issues. Several reports and summaries have been prepared on the more general issues. Yet, greater scientific and managerial expertise is needed to synthesize the information and apply NMFS knowledge in resource management areas to recurring, more-generic habitat issues. Bigford introduced and discussed a draft cooperative strategy for dealing with the problem of quantifying resource loss resulting from habitat degradation (Appendix L).

PANEL SUMMARIES

PANEL NO. 1: ACTIVITIES AND INTERESTS OF COUNCILS AND COMMISSIONS IN EXPANDING HABITAT PROTECTION

B. Higgins and A. Rosenburg of the Northeast Fisheries Science Center, G. Johnson of the New England Fishery Management Council, and T. Hoff of the Mid-Atlantic Fishery Management Council discussed the requirements for, and interest in, addressing fishery habitat protection through the Mid-Atlantic and New England Fishery Management Councils and the Atlantic States Marine Fisheries Commission. In introducing the panel discussion, the Magnuson Act was reviewed, noting the original requirement for the "best available" scientific information for habitat needs of the managed species, and highlighting the new requirement that regional fishery management councils "shall" comment on, and make recommendations for, any activity that "substantially" affects "anadromous" fish habitats. This latter requirement, combined with the existing broad definition of "anadromous" extending to cover freshwater and estuarine fish which migrate to ocean waters, significantly increases the responsibility of the councils to address habitat issues.

With the new Magnuson Act mandates on anadromous species habitats and a re-affirmation of concern for fish habitats for managed species, the New England and Mid-Atlantic Fishery Management Councils are working with NMFS to strengthen habitat sections of FMPs. G. Johnson noted that the New England Fishery Management Council is giving serious thought to the new habitat mandate, and continues to work with the NMFS Northeast Regional Operations Office's Habitat and Protected Resources Division and with the U.S. Fish and Wildlife Service's Northeastern Region in addressing environmental issues. T. Hoff noted that the Mid-Atlantic Fishery Management Council is addressing habitat issues through an active Habitat Committee, meeting eight times per year, and has recently argued effectively against several coastal developments. Hoff also noted that habitat needs are a significant part of the FMPs, with the Summer Flounder Fishery Management Plan discussing the habitat needs for spawning, larval, and juvenile stages to enable recruitment to the fishery. Secondly, the habitat section of the plan provides positions on environmental projects that affect the habitats for these life stages.

Hoff expressed a concern that addressing development issues, in addition to fishery management issues, would overextend the limited resources of the regional fishery management councils, and that the "burden of proof" on

whether a development could affect fish or their habitat should fall on project developers, not on government and the councils. Many managed resources are at critically low levels and will need habitat conservation as well as fishery management to be rebuilt to desired levels. Addressing this cooperatively within the limited resources of the regional fishery management councils and NMFS remains a critical challenge in implementing the 1990 Magnuson Act amendments and the Northeast Environmental Policy.

A. Rosenburg provided insight into the stock assessment process and how just such a process could relate to habitat assessment. After a basic introduction to population dynamics, he focused on how pollution/habitat loss factors would fit into population models. He concluded that any substantial population effects of habitat degradation could be determined through quantitative modeling. These effects would be manifested as mortality, reduced growth, and/or reduced reproductivity. With model outputs depicting reduced growth, reduced reproductive potential, and increased mortality, appropriate steps could be taken to include such effects into stock assessment models and the stock-rebuilding strategies required in managing the fishery. As this approach requires quantified information, synthesis would be needed for applying effects at the organism level to the population. Similarly, refinement of models and the development of methods to apply existing studies to the models would be needed.

In summary, the panel challenged workshop participants to incorporate habitat information and trends conditions into the fishery management process by identifying and quantifying population effects.

PANEL NO. 2: RESEARCH INFORMATION ON AMOUNTS AND MECHANISMS OF RESOURCE AND HABITAT LOSSES

A. Calabrese and A. White of the Northeast Fisheries Science Center, G. Thayer of the Southeast Fisheries Science Center, M. Monaco of the National Ocean Service's Strategic Assessments Branch, D. Simpson of the Connecticut Department of Environmental Protection, and S. Jordan of the Maryland Department of Natural Resources presented a series of talks on the existing scientific information concerning resource and habitat loss in both state and federal waters. The topic was introduced by Calabrese who noted that resource loss from environmental degradation can occur through: (1) direct mortality; (2) reduced reproductive potential; and/or (3) contamination which renders organisms undesirable or unsafe for human consumption.

Direct mortality can be caused by many anthropogenic means, with death occurring in time frames varying from minutes to years. Given these variables, this loss is not always quantifiable. However, in major events, such as the 1976 anoxia off New Jersey, the resource loss through direct mortality is both observable and quantifiable.

Reduced reproductive potential represents a mortality factor to the population, but not to the affected adults. This effect may take several years to manifest itself clearly, as it becomes detectable in the population. Estimates of lost reproductive potential can be approached through laboratory and field studies, in combination with mathematical modeling. One attempt being made in the Northeast Fisheries Science Center is to determine the effect of environmental contamination on winter flounder reproductive success in Long Island Sound. This is being done by controlled spawning -- in the laboratory -- of flounder from both degraded and reference areas, and then by comparing the fecundity and egg/larval viability of fish associated with the two areas. Field studies of larval and juvenile survival and growth will be made as well. The information collected will then be used in a population model.

Contamination of resource organisms may not necessarily cause death. Often, pollution renders organisms unsafe for human consumption, thereby removing them from harvest. This type of resource loss is common in the coastal clam fisheries and should be quantifiable.

Following this introduction, panel members presented research findings indicating connections between environmental conditions and resource productivity.

A. White reviewed the effects on Georges Bank, Nantucket Shoals, and Gulf of Maine shellfish resources from paralytic shellfish toxin contamination. Since a significant Atlantic surfclam and ocean quahog fishery has been closed and a potential sea scallop roe fishery is precluded from beginning, these phytoplankton-based toxins present an excellent example of a quantifiable resources loss due to biotoxin contamination.

While significant questions exist on the cause of this continuing biotoxin event, it is hypothesized that the underlying algal blooms may be enhanced by nutrient loading in coastal waters, with transport to, and residence in, the Georges Bank semi-enclosed system. The future of these fisheries depend partly on the future distribution of these toxin-carrying organisms. A scientific research program is being planned by the Northeast Fisheries Science Center to investigate the mechanisms perpetuating these toxins, as management strategies are being developed between NOAA and the Food and Drug Administration to close fisheries for human health and safety.

Similarly, in the inshore environment, sewage contamination has forced closure of many shellfish beds. Bacteria or viruses in sewage-contaminated water are accumulated by shellfish during their normal pumping activity, which can then cause human health problems if the shellfish are eaten raw. M. Monaco discussed the status of shellfish beds in the National Shellfish Register. Results for 1990 showed 62 percent of Northeast waters approved, 10 percent conditional, 3 percent restricted, and 25 percent prohibited, a slight decrease in the prohibited category from 1989. While there is presently no assessment of the value of unharvestable resources from these areas, plans exist to add this quantitative measure to the report.

Low dissolved oxygen levels in coastal waters as a cause for habitat and resource loss were discussed by D. Simpson, citing data from a Long Island Sound study by the state of Connecticut. Trawl surveys in western Long Island Sound have shown a distinct decrease in the number of species at oxygen concentrations below 3-4 mg/l. American lobsters appeared to be somewhat more tolerant than finfish and were captured at concentrations near 1 mg/l, while finfish populations were less abundant below 3 mg/l. The duration of survival of finfish and shellfish at these depressed levels has not been determined, and the relationship between oxygen concentration and mortality has not yet been established.

Estuarine fish communities were described by S. Jordan as possible indicators of environmental stress. In several cases, fish populations in Chesapeake Bay watersheds were shown to be on the increase where pollution abatement measures were implemented. As habitat continues to improve, it was surmised that a concomitant increase in the number and variety of fish species residing in the area would occur, as the communities return to their historical baseline. In addition, a premise was presented that salinity should be more closely studied as a factor in the post-larval survival of striped bass. Specific data were referenced showing a relationship among amount of runoff, salinity levels, and the Maryland young-of-the-year index, a measure by which the annual success of striped bass spawning is judged.

In support of this panel discussion, G. Thayer gave an overview of the environmental problems of the southeastern United States, with particular emphasis on habitat restoration. Coastal revegetation has led to some increases in animal life, but has failed to replace the functional value of natural habitat. In many cases, created habitats may revegetate, but traditional species are often replaced by opportunistic species with less ecological and economic value. Recognizing this, Thayer questioned the effectiveness of mitigation, the theory that creation of new habitats may offer greater potential than restoration, and the glaring absence of standards and criteria for evaluating mitigation success.

In conclusion, it was recognized that quantifying the functional value of habitats and the associated resource value needed to be planned into future research efforts.

PANEL NO. 3: HABITAT LOSS, MITIGATION, AND RESTORATION

T. Bigford, G. Thayer, M. Monaco, M. DelVicario of the EPA's Region II, and S. Chanesman of the NMFS's Office of Habitat and Protected Resources discussed various aspects of habitat loss, mitigation, and restoration. In introducing the panel, Bigford noted the "no net loss" concept and that federal agencies were increasing efforts to convert a worthwhile goal into a workable policy. To document losses, agencies now quantify habitat loss through mapping, tracking permit decisions, and calculating trend analyses. This is manifested in activities under NOAA's Coastal Ocean Program and its Status and Trends Program, the EPA's EMAP, the U.S. Fish and Wildlife Service's updating of the National Wetland Inventory maps, and the permit/project tracking activities of federal and state agencies.

While habitat loss is being assessed, mitigation activities are also being judged. A U.S. Army Corps of Engineers and NMFS cooperative agreement confirms a commitment to effective restoration and creation of fish habitat. This couples with the Corps of Engineers 22-million-dollar national program to mitigate effects from civil works projects. The continued future of these efforts resides in quantifying the effectiveness of mitigation actions.

Restoration will be NOAA's focus in habitat work in the near future. With Superfund settlements occurring, and the likelihood of a settlement on major oil spills, site-specific restoration will constitute a major portion of NOAA's habitat activities. Specifically, the NOAA Damage Assessment and Restoration Program's Regional Restoration Centers promise to colocate the expertise needed to conduct an effective program. But for this to succeed, quantitative information will be needed on losses of habitat functional value, on damage assessment, and on fish habitat recovery rates.

M. Monaco presented the capabilities of the National Ocean Service's Strategic Assessments Branch for support of habitat assessment, mitigation, and restoration activities. Focusing on five areas (*i.e.*, human activities, pollution sources, physical environment, biogeographic characterization, and decision support), the Strategic Assessments Branch is providing data and information bases in a computerized format to decision makers. These include "Geo-Coast" for producing maps, "CMAS" for biogeographical analysis of living marine resources, and "COMPAS" for browsing through water- and land-use activities, physical and hydrological characteristics, and background sociopolitical information against which resource assessments can be compared. Monaco stressed that a great deal of information was available for making informed decisions on habitat value, use, and loss, but also recognized that closer coordination among agencies could strengthen the data bases and enhance applications.

In regard to assessing habitat loss, mitigation, and restoration, M. DelVicario discussed EPA's recent emphasis on wetland mitigation and restoration and the difficulties in being successful through a site-by-site approach. In many cases, a mitigation project fails simply because the surrounding degraded environment degrades the mitigation project. Closer scrutiny of the potential success of a mitigation project is planned, prior to approval. In addressing future mitigation projects, EPA plans to develop comprehensive plans for Long Island Sound, Hudson River - Raritan Bay Estuary, and Delaware Bay that will lead to successful mitigation efforts. NMFS cooperation and scientific expertise are key in this EPA effort, recognizing NMFS focus on restoring the functional values of fishery habitats

and concerns for the long-term recovery for the resources.

G. Thayer acknowledged the needs for effectively quantifying resource loss and recovery, and described the new Restoration Center being established by NOAA's Damage Assessment and Restoration Program. The Restoration Center's goals are to: (1) become a focal point for habitat restoration expertise; (2) assume the lead for planning, implementing, and monitoring restoration activities; and (3) provide habitat restoration expertise to the Damage Assessment Center component of the Damage Assessment and Restoration Program. The Restoration Center will play a key role in NOAA's future Superfund, oil spill, and habitat assessment and restoration activities. A national program is being proposed, including a regional component in the Northeast. This program should greatly enhance NMFS's effectiveness in participating in interagency efforts to quantify resource loss and recovery.

The Coastal America initiative, an interagency approach to conserve habitats, was presented by S. Chanesman. Still being developed, the initiative proposes to expand habitat restoration activities within existing mandates and will lead to closer cooperation among NMFS, EPA, U.S. Army Corps of Engineers, and U.S. Fish and Wildlife Service in meeting mandates for conserving coastal habitats. The initiative's three priorities of sediment contamination, non-point-source pollution, and overall habitat degradation mirror the principle needs of all resource agencies.

In summary, the panel stressed that quantified information would remain essential for effective fish habitat conservation and management. This could be accomplished through a cooperative strategy to develop quantified data on resource loss (Appendix L).

CONCLUDING DISCUSSIONS

T. Bigford led the concluding discussion of the workshop, focusing on the draft strategy and possible future efforts to quantify resource loss and make good use of the quantitative information. Recognizing the effectiveness of the stock assessment workshop process, A. Rosenberg proposed that a similar approach, targeted at the population level, could be used for habitat assessments. Rosenberg further suggested that a single-species approach, combining existing organism-level research with population assessments, would provide a model for judging the effects of anthropogenic activities on a specific population. Because the largest data base available now is for winter flounder, he suggested that winter flounder be used as the test species. However, he also recognized that most of the methodology for this approach must be developed.

As an option to the resource population approach, the use of a human activities approach was also discussed, recognizing that most habitat decisions are made from the human activities context and that relevant data bases exist in all agencies. Again, the need for quantitative information on the habitats and species being affected was stressed, regardless of the approach taken.

Another approach proposed was the use of "habitat suitability indices" commonly used in freshwater ecology. Because this procedure is well established in closed systems, it was felt that bringing this technique into marine habitat assessment might be useful.

During the discussion, it was acknowledged that future workshops should be held for the exchange and analysis of data sets within specific methods in order to develop more effective habitat/resource assessment procedures. In this regard, it was agreed that winter flounder provided the best test species for a future habitat assessment workshop, and that necessary methods must be developed. In addition to winter flounder, striped bass was offered as a second potential candidate for modeling. But critical to either study is linking organism-specific effects to populations through a quantitative process.

At the conclusion of this discussion, the workshop was adjourned.

NEEDS AND PROPOSED ACTIONS

An interpretive distillation of the workshop discussions produced the following list of needs and proposed actions.

NEEDS

1. Estimate resource losses resulting from harvest closures due to contamination -- this is tractable.
2. Review the results of biological and toxicological research at organism or microcosm level to develop estimates of population effects of habitat loss or degradation.
3. Develop protocols and methods to respond to an environmentally induced fishery mortality episode; efforts should be undertaken to define the affected area and quantify the resource loss.
4. Establish a cooperative information and guidance network regarding habitat restoration activities and their effectiveness.
5. Create an electronic archive and interactive network to exchange habitat/resource data and information.
6. Establish an interagency collaborative process to assess and summarize resource effects of habitat loss and degradation in the Northeast.

PROPOSED ACTIONS

1. NMFS Northeast Region personnel should work with the National Ocean Service's Strategic Assessments Branch and with state agencies to include resource harvest loss estimates with summary reports of shellfish closures, and provide these estimates to all pertinent fishery management commissions, councils, and regulatory agencies.

2. NMFS Northeast Region and interested state personnel should review fishery population and production models and biological effects results, to develop a method to estimate resource losses related to reduced reproductive potential, decreased growth rates, and other physiological reactions to stress.
3. Identify a group of individuals in the habitat and resource-related agencies in the Northeast who can be contacted in the event of a fishery-mortality episode to develop an estimate of resource loss.
4. Form an interagency working group in the Northeast to plan a means for exchanging information concerning restoration research and techniques, possibly through a series of workshops and/or newsletters, and to work in conjunction with the NOAA Restoration Center.
5. The NMFS Northeast Regional Operations Office should canvass other habitat/resource agencies in the Northeast to determine their plans to create and link electronic data archives and networks.
6. Plan and initiate a series of interagency workshops to improve methods for estimating habitat-related resource losses and to produce state-of-the-art estimates of loss. The first workshop should address losses in winter flounder stocks resulting from habitat loss or degradation.

Appendix A
Agenda for First NMFS Northeast Environmental Workshop

FIRST ENVIRONMENTAL WORKSHOP

LOCATION: NMFS - NORTHEAST REGIONAL OFFICE: GLOUCESTER, MA

DATES: MARCH 13-14, 1991

PURPOSE: TO DEVELOP A STRATEGY FOR COOPERATIVE ASSESSMENT AND QUANTIFICATION OF LIVING MARINE RESOURCE LOSS IN THE NORTHEASTERN UNITED STATES DUE TO HABITAT LOSS AND ENVIRONMENTAL DEGRADATION

SPONSORED BY: NMFS NORTHEAST ENVIRONMENTAL COUNCIL

MARCH 13 - WEDNESDAY

8:00-9:00	Registration
9:00-9:15	Introduction to the Northeast Regional Environmental Council and its Activities to Date. - M. Ingham, Chairman, Environmental Council
9:15-9:45	Keynote Address: Fishery Management Needs for Information on Changes in Stocks Resulting From Habitat Loss or Degradation. - R. Roe, Regional Director, NMFS, NE Region
9:45-10:15	Environmental Quality and Resource Health - Quantifying Resource Loss - J. Pearce, Science and Research Director, NMFS, NE Center
10:15-10:30	Break
10:30-11:00	The 12-Mile Sewage Dumpsite Study: A Case Study of change following pollution abatement. - J. O'Reilly, Chief, Chemical Processes Branch, NE Center
11:00-11:30	EMAP Near Coastal Component: A Program to Measure Indicators of Ecosystem Health in U.S. Estuaries - J. Paul, Environmental Monitoring and Assessment Program, EPA

11:30-12:00	Gulf of Maine Program - An Initiative in Regional Cooperation. - P. Hughes, MA Coastal Zone Management Office
12:00-12:30	Information Needs for Habitat Protection and Restoration/Presentation of Draft Cooperative Strategy for Quantifying Losses. - T. Bigford, Chief Habitat and Protected Resources Division, NE Region
12:30-2:00	Lunch
2:00-4:00	- PANEL 1: B. Higgins, Panel Chair Activities and Interests of Councils and Commissions in Expanding Habitat Protection. Presentations and discussion involving all.

MARCH 14 - THURSDAY

8:30-9:00	Registration
9:00-9:30	Summary of first day's proceedings. - M. Ingham, Chairman, Environmental Council
9:30-11:30	- PANEL 2: A. Calabrese, Panel Chair Research Information Concerning Amount and Mechanisms of Resource and Habitat Losses. Presentations and discussion involving all.
11:30-12:45	LUNCH
12:45-2:45	- PANEL 3: T. Bigford, Panel Chair Habitat Loss, Mitigation & Restoration. Presentations and discussion involving all.
12:45-3:00	BREAK
3:00-3:45	Discussion of cooperative strategy for quantifying losses. - T. Bigford, Moderator
3:45-4:00	Summary of proceedings and conclusions. - M. Ingham, Chairman, Environmental Council

FIRST ENVIRONMENTAL WORKSHOP PANELS

PANEL 1. Activities and Interests of Councils and Commissions in Expanding Habitat Protection

Bruce Higgins - Chair
NMFS Northeast Fisheries Center, Woods Hole, MA

Tom Hoff - Mid- Atlantic Fishery Management Council Needs
Mid-Atlantic Fishery Management Council, Dover DE

Gail Johnson - New England Fishery Management Council Needs
New England Fishery Management Council
South Harpswell, ME

Andy Rosenburg - Stock Assessment versus Habitat Assessment
NMFS Northeast Fisheries Center, Woods Hole, MA

PANEL 2. Research Information Concerning Amount and Mechanisms of Resource and Habitat Losses.

Tony Calabrese - Chair
NMFS Northeast Fisheries Center, Milford, CT

Alan White - Paralytic Shellfish Toxins and Their Impact on Offshore Shellfish Stocks
NMFS Northeast Fisheries Center, Woods Hole, MA

Gordon Thayer - Research on Functional Values and Mitigation
NMFS Southeast Fisheries Center, Beaufort, NC

Mark Monaco - Shellfish Water Quality
NOS Strategic Assessments Branch, Rockville, MD

David Simpson - Low DO Impact on LMRs in Long Island Sound
Division of Marine Fisheries, Waterford, CT

Steve Jordan - Estuarine Communities as Indicators of Environmental Stress
Department of Natural Resources, Anapolis, MD

PANEL 3. Habitat Loss, Mitigation, and Restoration.

Tom Bigford - Policy Considerations
NMFS Northeast Regional Office, Gloucester, MA

Mark Monaco - Quantifying Habitat Trends
NOS Strategic Assessments Branch, Rockville, MD

Mario DelVicario - Mitigating Habitat Losses
EPA Region II, New York, NY

Gordon Thayer - Restoring Degraded Habitats
NMFS Southeast Fisheries Center, Beaufort, NC

Appendix B
List of Participants for First NMFS Northeast Environmental Workshop

WORKSHOP PARTICIPANTS

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Jeffrey Benoit Massachusetts Coast Zone Management Office	617-673-5100
David Simpson Connecticut Department of Environmental Protection	203-443-0166
Linda Gunn Connecticut Department of Environmental Protection	203-443-0166
Eleanor Mariani Connecticut Department of Environmental Protection	203-443-0166
Steven Jordan Maryland Department of Natural Resources	301-974-3767
Leigh Bridges Massachusetts Division of Marine Fisheries	617-727-3193

Appendix C
NMFS Northeast Environmental Council Issue Paper

December 3, 1990

NER/NEC ENVIRONMENTAL COUNCIL

ISSUE PAPER

Issue: Need to quantify losses of living marine resources resulting from environmental degradation or habitat loss.

Background: There are frequent qualitative references to loss of fishery resources resulting from pollution and other forms of environmental degradation, or destruction of coastal or estuarine habitats, but quantitative estimates of the amount or value of lost resources are rare. Such estimates could improve NMFS' ability to influence decisions on resource-related issues, to account for pollution and degradation impacts in management strategies, and to enhance general appreciation for living resources and their habitats.

The statements made in fishery management plans regarding resource losses due to habitat loss or degradation are characteristically non-quantitative and can be summarized as follows: Pollution and habitat loss are bad for fish. How can a resource or environmental agency act on an assertion that vague? NMFS expends a great deal of effort trying to accurately quantify the effects of fishing on stocks, but comparatively little trying to quantify the effects of environmental degradation or habitat loss on fish populations.

In 1976 an unusually well-documented event involving resource losses (probably caused by natural environmental changes) occurred in the inner New York Bight. A rather large (8,600 km^2) area of bottom water became critically hypoxic or anoxic, resulting in losses in shellfish stocks estimated to amount to:

141,500 tons of surf clam meats worth (dockside)	$120,000,000
51,000 tons of ocean quahog meats worth (dockside)	$34,000,000
8.8-12.9% of sea scallops worth (dockside)	$ 72,000
96.6 tons of lobsters worth (dockside)	$ 410,000
	$154,482,000

(Source: Swanson, R. L. and C. J. Sindermann, 1979. NOAA Professional Paper No. 11)

The resource losses in the 1976 hypoxia event were not permanent, and the shellfish populations have returned to pre-event levels, generally. In the case of the surf clam population it rapidly grew to a size larger than the pre-event size, because the hypoxia had such an adverse effect on predators.

Another case of resource loss because of bottom water hypoxia is evolving in western Long Island Sound, but no quantitative estimate of the resource loss is available at this time. The hypoxia in this situation is caused largely by discharges of nutrients from 44 sewage treatment plants ringing the western Sound. The cost to remove the nutrients from the discharges has been set at six billion dollars. (Source: New York Times, 9/7/90)

A well-documented event involving resource losses because of point-source pollution is the kepone contamination of the James River, a section of the Chesapeake Bay, which resulted in a closure or seasonal closure for bluefish, Atlantic croaker, American eel, striped bass, and weakfish, from 1976 through 1988. The estimated revenue losses for 1976 (alone) are 0.8 million dollars at the harvester level, and 2.2 million dollars at retail level (Losses to Fishing and Related James River Industries, unpublished report, Virginia Marine Resources Commission, 1982)

Perhaps of greater magnitude and greater concern are the small losses which occur in thousands of locations throughout the coastal and estuarine waters of the Northeast. These losses can result from point-source pollution, non-point-source pollution or small-scale habitat destruction such as that resulting from filling and bulkheading.

An example of resource losses of this sort is the gradual increase in acreage closed to shellfishing because of sewage or septic system contamination from Maine to Virginia. Although the shellfish in question have not been killed by the contaminants, they are too contaminated to be safely consumed. The sum of these losses in terms of shellfish or dollar value has not been determined, but could be.

In 1985 (the most recent year summarized) 24% of the estuarine shellfishing waters of the Northeast Region (Virginia-Maine), amounting to 591,340 acres, was closed to shellfishing. An additional 5% (147,154 acres) was restricted to harvest only if depuration was used to purify the shellfish. Three percent (84,117 acres) was conditionally approved for harvest only when water quality was acceptable. The situation described by these statistics is not as encouraging as it appears, because, "Much of the approved area is not productive because of extreme salinities, or lack of suitable depth, substrate, or habitat for molluscan shellfish."
(Source: The quality of shellfish growing water on the East Coast of the United States. NOAA/OMA/OAD. March 1989.)

Raritan Bay was the first large area closed to shellfishing in the Northeast, when pollution and public health concerns forced its closure in the 1920's. At that time the bay was yielding about 400,000 bushels of oysters a year and about 100,000 bushels of hard clams. Newspapers at the time carried many stories about the polluted Raritan Bay oysters and the typhoid they transmitted to people. As a consequence, sales of

oysters from other estuaries decreased significantly because of general fears of pollution. Presently there is a fishery for hard clams in the bay, but all the clams harvested must be taken elsewhere for depuration before they can be safely consumed. (source:personal communication from Clyde MacKenzie, Sandy Hook Lab.)

Closures of shellfish beds because of sewage pollution off the open Atlantic coastline are less common. One such closure is the 113 square nautical mile (95,643 acre) area around the center of the 12-Mile Dumpsite in inner New York Bight. This area was closed to shellfishing by FDA in 1970, because of unacceptably high concentrations of coliform bacteria in the waters of the dumpsite. The shellfish stocks presently found in this area (surf clam and ocean quahog) are not present in commercially profitable densities (estimated to be 3.4 clams per tow and 7.6 quahogs per tow), so there is no significant harvest being blocked by the closure now, but as the site recovers from 64 years of sludge dumping (1924 - 1987) commercial concentrations may develop.

Along the New Jersey coast, however, a significant shellfish resource is being lost because of area closures due to sewage pollution. Twenty eight percent (amounting to 78,239 acres) of the 3 mile-wide coastal strip was closed in 1989. The surf clam resource withheld from harvest by that closure is estimated to be about 2,233,560 bushels. (Source: N. J. Dep't Env'l Protection, Division of Water Resources)

A recent example of a shellfishery closure in shelf waters because of contamination is the surf clam closure on Georges Bank because of contamination with PSP (paralytic shellfish poison) toxins. The monitoring in this case was done by the state of Massachusetts and NMFS. The closure withholds about 250,000 bushels ($3.5 M) of shellfish from harvest, at least temporarily. It is unknown at this time if the contamination is linked with pollution in coastal waters of the Gulf of Maine, where PSP contamination of shellfish in Maine state waters has been chronic since 1972. In 1980 it was responsible for an $8M loss to the shellfish industry in that area.

An example of finfish resource losses from non point-source pollution is the reduced recruitment of winter flounder resulting from pollution or destruction of nursery habitats in the upper portions of estuaries in the Northeast. According to Azarovitz (p.122, Fish Distribution, MESA New York Bight Atlas Monograph 15), winter flounder eggs and larvae are particularly susceptible to toxic wastes in sediments. Also the juveniles and young adults are dependent on forage in the intertidal zone, thus dredging, filling and bulkheading would have a significant impact on their survival. The magnitude of the lost recruitment from these causes has not been estimated.

Discussion:

Resource losses from environmental degradation or habitat loss can occur in several ways:

1. Mortality of organisms
2. Reduced reproductive potential of organisms
3. Contamination of organisms rendering them unsafe or undesirable for consumption by predators, including man.

Mortality as a consequence of pollution or other environmental degradation can be the result of direct physiological effects, increased predation because of behavioral changes induced in the target organisms, or decreased vitality and immunity leading to disease. The time required for death of the resource organisms may range from minutes to years depending on the concentration of the pollutant or the severity of the habitat change.

Detection of mortality from environmental causes is very difficult in heavily fished stocks, because the major decreases in abundance which occur from fishing mortality obscure any other effects from environmental degradation or habitat destruction. Annual abundance estimates determined for heavily-fished stocks will yield no useful information regarding non-fishing mortality; such information must be obtained from "body counts" at the scene of fish kills, by use of mathematical models, or by monitoring disappearance of early life stages from their habitats.

Reduced reproductive potential represents mortality for a stock or population, but not for the exposed adults. Accordingly, this mortality may take several years to manifest itself clearly and may be difficult to recognize and monitor by means of abundance estimates. Estimates of lost reproductive potential can be made by 1.) experimentally establishing the reproductive response to contaminant concentrations and monitoring the contaminant in the habitat, and/or 2.) assembling circumstantial evidence (abundance vs. contaminant concentration) in field studies. Either method eventually requires the use of a mathematical model to produce an estimate of reduced juvenile abundance. There is a possibility of producing estimates of winter flounder losses in Long Island Sound by these methods using data obtained from studies conducted by the Milford Laboratory of the Northeast Fisheries Center.

Contamination of resource organisms may in no way contribute to their mortality, but render them unsafe for human consumption, thereby removing them from harvest. Although the stocks would not suffer under those circumstances, the resources would be lost, as long as they remained contaminated. Detection of

resource losses from tissue contamination depends on the existence of an active program of monitoring concentrations of contaminants in resource species. For example, there is a network of state and municipal programs to monitor coliform bacteria concentrations in shellfish and surrounding waters that is used to determine which areas should be closed to harvest. In addition, some states conduct tests for coliform bacteria on lots of shellfish entering the market supply system, to protect consumers from illegally harvested contaminated shellfish. This multi-agency network for monitoring and regulating nearshore and estuarine shellfisheries has led to the closure of thousands of acres of shellfish beds in Northeast coastal waters.

Until quantitative estimates of resource loss are available there is no way to assess the severity of the effects of habitat loss and environmental degradation on fisheries in the Northeast Region. Frequent restatement of the qualitative assertions that pollution kills or contaminates fish and that habitat destruction is harming fish stocks do not make those assertions any more convincing or compelling. Some quantitative measures of resource losses are required.

Proposed Actions: The following steps are recommended in an effort to provide some quantitative loss estimates:

1) Convene a workshop in early 1991 to discuss resource losses, assemble literature and unpublished data/observations, and begin the effort of publishing a compendium of best-available information for use by decision makers. The focus should be on quantifying habitat degradation and lost harvests, including the connections between habitat and productivity.

2) Improve utilization of and coordination with NOAA/NOS and other data sources to document habitat and resource trends. This may be most possible in coastal waters where habitat degradation has been most common and where such records as shellfish harvests could enable comparisons. This could be a good opportunity to collaborate with state agencies, which we must do, if we are to progress toward our overall mission of integrating habitat issues into fishery management decision making. We might be able to conduct a pilot study with the Gulf of Maine Initiative (maybe in conjunction with the two Canadian provinces) or to expand the literature assessment work being conducted by Diane Rusanowsky and Mike Ludwig at the NER Habitat Conservation Branch office in Milford, CT.

3) Direct a new bioenvironmental research group to study the connection between habitat degradation and resource loss. Use mesocosm experiments (perhaps the URI MERL tanks through our Cooperative Marine Education and Research agreement) to identify basic processes and relationships. Pursue field work, as a follow-up to laboratory experiments, to confirm real-world situations.

Appendix D
Overheads for Introduction to NMFS Northeast Environmental Council

NORTHEAST REGION NMFS

ENVIRONMENTAL COUNCIL

13 MARCH 1991

Bob Pawlowski, Exec. Sec. (NER)

Tom Bigford (NER)

Bob Learson (NEC)

Tony Calabrese (NEC)

Anne Studholme (NEC)

Jay O'Reilly (NEC)

Mert Ingham, Chairman (NEC)

FUNCTION OF EnCo

Advise Regional Director (NER) and Science & Research Director (NEC) on issues, problems and policies related to the effects of habitat loss or environmental degradation on living marine resources.

CHARTER OF EnCo

1. **Evaluate priority habitat issues.**
2. **Produce comprehensive assessments and reports.**
3. **Review ongoing habitat research.**
4. **Identify research needs.**
5. **Recommend research strategies.**
6. **Develop contingency plans to deal with long-term environmental issues.**
7. **Conduct workshops on key habitat issues of regional concern.**

STATUS OF EnCo PROJECTS - 13 MARCH 1991

Project No.

1. Determine appropriate level of participation in national and regional programs dealing with habitat or environmental problems. (in progress)

2. Review , revise, and quantify habitat sections of fishery management plans. (in progress)

3. Develop research plan for investigation of offshore biotoxins and their effects on biota and humans. (in progress)

4. Quantification of resource losses resulting from environmental degradation or habitat losses in the N E Region. (issue paper prepared Dec 90, workshop Mar 91)

5. Develop protocols for working with NOS/OMA in response to marine pollution incidents. (in progress)

6. Review and prepare recommendations for specific problem-oriented research on fishery habitat-related issues. (in progress)

7. Review EPA's EMAP marine program plans for the northeast and identify components relevant to NMFS. (findings reported Aug 90, liaison established Dec 90)

8. Develop plan for the formation of a nearshore and estuarine bio-environmental research group in the NEFC. (on hold, superseeded by plans at NMFS headquarters level)

9. Identification of all environmental programs in the northeast and determine those with relevance to NMFS. (first version of report completed Sep 90 - held in computer file)

Appendix E
NMFS Habitat Conservation Policy

11-25-83
Vol. 48 No. 228

federal register

Friday
November 25, 1983

Habitat Conservation; Policy for National Marine Fisheries Service (NMFS)

AGENCY: National Oceanic and Atmospheric Administration (NOAA), Commerce.

National Oceanic and Atmospheric Administration

[Docket No. 31028-211]

Habitat Conservation; Policy for National Marine Fisheries Service (NMFS)

AGENCY: National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice of effective NMFS habitat conservation policy.

SUMMARY: NOAA issues a policy for the National Marine Fisheries Service (NMFS) which provides a focus for NMFS' habitat conservation activities, while at the same time integrating habitat conservation considerations throughout the major programs and activities of the Agency. The policy also encourages greater participation by the Regional Fishery Management Councils, the States and others in habitat conservation matters. This action is necessary in order to allow NMFS to focus its habitat conservation activities on those species for which NMFS is primarily responsible or which are the subject of a NMFS program. The effect of this policy will be to make NMFS' habitat conservation activities more responsive to the goals and objectives of the Agency as set forth in the NMFS Strategic Plan, and to allow priorities to be set and defended.

EFFECTIVE DATE: November 21, 1983.

FOR FURTHER INFORMATION CONTACT: Herbert L. Blatt, Chief, Policy Group, NMFS, 202-653-7551, or Kenneth R. Roberts, Chief, Habitat Conservation Division, NMFS 202-634-7490.

SUPPLEMENTARY INFORMATION:

Background

The NMFS has primary Federal responsiblity for the conservation, management, and development of living marine resources and for the protection of certain marine mammals and endangered species under numerous Federal laws. The Agency also has responsibilities to the U.S. commercial and marine recreational fishing industry, including fishermen, and to the States and the general public. These responsibilities are inherent in NMFS' mission which is "To achieve a continued optimum utilization of living marine resoures for the benefit of the Nation." NMFS is vitally concerned about the habitats that support living marine resources since the well-being of these resources and the fishing industry depends upon healthy and productive habitats.

The U.S. commercial and marine recreational fishing industry makes an important contribution to the Nation's economy. The commercial fishing segment of the industry produces food and industrial goods that contribute $7 billion annually to the gross national product. Including fishing vessels and shoreside businesses, the commercial fishing segment employs nearly 300,000 persons. Marine recreational fishing provides opportunities for recreation as well as a substantial quantity of food for 15 to 20 million anglers in the United States. Catch by marine recreational fishermen accounts for an estimated 30 to 35 percent of the total U.S. finfish harvest used for food. Expenditures by these fishermen, the value of associated industries (such as tackle, boat, and trailer manufacturers, and the party and charter boat industries), and the value of the recreational fishing experience itself are significant components of the U.S. economy. Direct expenditures by marine recreational fishermen are estimated to be at least $5 billion annually, not to mention the indirect economic impacts generated from these expenditures.

Marine mammals and endangered species are also important to the Nation in terms of their domestic and international significance—aesthetic, recreational, ecological and economic.

Coastal and estuarine areas and their associated wetlands are vitally important as spawning and nursery grounds for both commercial and marine recreational fishery resources. Approximately two-thirds of our important fishery resources depend upon these areas which also serve as habitat for many species of marine mammals and endangered species. However, population shifts to coastal areas and associated industrial and municipal expansion have accelerated competition for use of the same habitats. By 1990, 75 percent of the U.S. population will live within 50 miles of the coastlines. Increasing efforts to develop new or alternate sources of energy are further stressing important living marine resource habitats. As a result, these habitats have been substantially reduced and continue to suffer the adverse effects of dredging, filling, coastal construction, energy development, poilution, waste disposal, and other human-relatd activities. In the case of wetlands, from 1954 to 1978 there was a average annual loss of 104,000 acres which was a ten-fold annual increase in acreage lost between 1780 and 1954.

Recognizing the importance of habitat to the management and conservation of living marine resources, NMFS proposed a new habitat conservation policy for the Agency. The notice of proposed policy, published in the **Federal Register** on July 19, 1983 (no. 139), at 48 FR 32847, solicited public comments.

Response to Public Comments

During the comment period, twenty-five letters were received from other Federal agencies, State governments, Regional Fishery Management Councils, and organizations representing millions of citizens. The commenters, in general, supported the proposed policy, stating it is long overdue and commending the approach. However, certain of the commenters had specific concerns which are set forth below along with NMFS' response.

Policy

Comment: Implicit in the goal and mission statement of NMFS is the assumption that populations concerned would be usable. This should be clarified.

Response: NMFS agrees that the policy should make clear that the habitat conservation activities of the agency are to maintain or enhance the capability of the environment to, among other things, produce fish and shellfish that are safe and wholesome. The wording has been amended accordingly.

Comment: Several commenters caution against too narrowly defining scope of policy. It should signify the need to give priority attention to those species for which direct managment presently is Agency responsibility and it should *clearly* state that NMFS has stewardship responsibility for all living marine resources under Federal jurisdiction.

Response: NMFS does not believe the language needs modification. While NMFS has overall responsibilty for living marine resources, it is necessary to focus NMFS' habitat conservation activities on those resources over which it can influence management regimes throughout the range of the species. NMFS' activities with respect to one species could benefit other species that depend on a particular habitat.

Policy Framework

Comment: Suggest clarifying paragraph 1, Policy Framework, to indicate NMFS also has management responsibility for species for which no Fishery Management Plans are planned, such as squid or herring in the Gulf of Mexico. This could be accomplished by rewording clause "(1) covered or to be covered" to "(1) covered or subject to being covered."

Response: For clarity, NMFS agrees to suggested change.

Implementation

Comment: The coordination mechanism for policy's implementation is not described. It is also not clear how interested public and conservation groups will be able to interact and have input into this important decision.

Response: The coordination mechansim will be developed by each region, following national guidelines, during the implementation phase. It is expected that NMFS Regional and Center Directors will discuss their programs with their constituents in order to make determinations with respect to priorities.

Comment: In Implementation Strategy No. 4, second sentence, urge addition of "artificial impoundments" to list of activities which have potential for habitat degradation.

Response: NMFS agrees to this addition.

Comment: Under Implementation Strategy No. 7, suggest policy cover catadromous as well as anadromous species.

Response: Suggestion refers to NMFS' involvement in fresh water. While catadromous species are not excluded, NMFS intends to focus on anadromous species.

Comment: Implementation Strategy No. 3(a) implies that fishermen may be a threat to fishery habitats. Statement should be clarified to address possible conditions under which fishing poses a threat to habitat.

Response: Under certain conditions, fishermen can cause damage to habitats, e.g., bottom gear fishing, vessel discharges, etc. The Regional Fishery Management Councils may deal with such under the Magnuson Fishery Conservation and Management Act (Magnuson Act), but may not control actions by others. There was no intention to single out fishermen as a threat to habitat as they realize the importance of healthy habitats and are beneficiaries of such.

Comment: Implementation Strategy No. 3(a) states that Fishery Management plans should include "proposal of measures to preserve, protect and restore habitat." Should be clarified to indicate range of "measures" which could be implemented. Should also indicate that no measures may be required in many fisheries where habitat issues are not significant.

Response: The range of measures is intentionally left up to each Regional Fishery Management Council, depending on needs of the fishery. The Councils will have the same prerogatives regarding habitat conservation that they have with respect to any other management measure contained in the Fishery Management Plans. The language of 3(a) has been modified to indicate that measures will be proposed only where appropriate.

Role of Regional Fishery Management Councils

Comment: Implementation Strategy No. 3(a) imposes strict requirements on the Regional Fishery Management Councils above and beyond the requirements of the Magnuson Act. Talk of a partnership between NMFS and the Councils is contradicted by a clear threat to disapprove Fishery Management Plans that do not meet requirements proposed by NMFS. Moreover, this strategy is an attempt to reduce the responsibilities of the Councils assigned by Congress.

Response: Implementation Strategy No. 3(a) strengthens, not weakens or reduces, the role of the Councils regarding habitat conservation. This strategy does not impose requirements beyond the Magnuson Act, since habitat is an important element in fishery management.

Comment: It would be appropriate to refine the planning and implementation strategies to assure the Councils a partnership level role in any actions taken under the policy once it is implemented. If workshops to further develop the policy format are being considered, the Councils would appreciate an opportunity to participate.

Response: The Councils are intended to have an important partnership role and NMFS expects to contact them from time to time during policy implementation planning and development.

Comment: Minimum Fishery Management Plan descriptions called for could impose an impractical burden on plan development. For example, 80% of salmon catch in Alaska includes fish from habitat areas outside Alaska. The Councils are conscious of importance of habitat and need to protect it, but the Councils are not in a position to carefully review the work of everyone on the coasts and oceans and assess or restate the assessments of other agencies which do monitor the impact those actions may have on the environment.

Response: NMFS believes an erroneous impression was created by wording in Implementation Strategy No. 3(a) which stated "The Regional Fishery Management Councils should address habitat considerations in their Fishery Management Plans, where applicable, based on the best available information *from all sources which can be coordinated by NMFS/NOAA.*" The underlined words have been deleted to make clear the Councils will be obliged to review only information made available to them by NMFS/NOAA and others during their plan deliberations. This will be an evolutionary process and will not impose an impractical burden on the Councils in plan development. NMFS will work closely with the Councils to make them aware of habitat conservation matters they might need to consider.

Comment: Several commenters stated that Implementation Strategy No. 3 outlines the development of a potentially powerful framework for building a constructive partnership between the Councils and NMFS for habitat conservation. Although the Councils presently may become as involved in maintenance of habitat as their authorities allow, they have played a minor role in habitat conservation to date. If this strategy is to be implemented successfully, NMFS will have to be highly responsive to Council needs with technical assistance and information delivered both timely and adequately. Parhaps Implementation Strategies Nos. 1 and 2 should make an even stronger reference to development of research priorities and programs in response to Council needs.

Response: NMFS expects that Implementation Strategy No. 3(b) will result in NMFS providing the Councils with needed information and support. Again, this will be an evolutionary process so as not to place an undue burden on the Councils. The products resulting from implementation of Strategies Nos. 1 and 2 will provide the basis for the information provided to the Councils.

Comment: Suggest following change in Implementation Strategy No. 3(a), second paragraph: "Where appropriate, existing FMPs *should* be amended to meet these standards."

Response: NMFS agrees to recommended change.

Comment: Caution against over reliance on Councils as their desires may not always lead to non-overfishing or non-resource exploitation policies that NMFS supports in conjunction with wetlands protection and fisheries management.

Response: NMFS has every confidence that the Councils, in partnership with NMFS, will not undertake actions that will lead to overfishing or over exploitation of the resource.

NMFS' Role Vis-a-Vis Regional Fishery Management Councils and States

Comment: Several commenters believe that a number of statements within the policy convey the impression that NMFS intends to inject itself into an

active role of fishery management in the Fishery Conservation Zone (which is the responsibility of the Regional Councils) and within the territorial seas (which is under States' jurisdictions). Overall conclusiom is that the policy, as written, suggests the intention of assigning to NMFS a role in fishery management which heretofore has ben filled by the Councils and concerned coastal States.

Response: The policy recognizes a partnership between NMFS and the Councils under the Magnuson Act and does not create any greater role for NMFS or the Councils than that which is currently required under the Act. The policy is not intended to usurp the Council's responsibilities. It provides the bsis for considering habitat during the Councils' development of Fishery Management Plans. Moreover, the policy does not provide for NMFS' intervention in State management of State resources in State waters. It indicates that NMFS and the Councils have an interest in conservation of the habitats of species managed under the Magnuson Act.

Comment. The policy should provide for recognition of States' roles in habitat conservation and for more definitive mechanisms for working with States in this regard. Several opportunities exist: (a) Under Implementation Strategy No. 1, Regional Directors should include State programs in their inventory of strategies to address habitat issues. There should be formal consultation with, and opportunity for comment by, States prior to adoption of regional habitat protection plans; (b) existing grant programs should recognize the validity of habitat conservation matters; and (c) procedures for NMFS' coordination with the States regarding Fish and Wildlife Coordination Act reviews should be adopted.

Response: Implementation of the policy will be in full recognition of States' roles in habitat conservation. The policy in no way evisions a reduction of State activities. It is expected that States will be consulted during planning and implementation. It is expected that NMFS' grant programs, as well as other programs, will consider habitat as part of the integration process.

Interactions With Other Agencies

Comment: One State commented that the Corps of Engineers has been traditionally recognized as the Federal agnecy for coastal habitat protection. The Corps' working relationship with coastal States is a long proven process. Implementation of the policy will add another layer of Federal involvement to what is already in place.

Response: The policy does not provide for replacement of the Corps of Engineers or any other agencies having interests in habitat conservation. NMFS, under the Fish and Wildlife Coordination Act, will continue to provide recommendatons to the Corps regarding its issuance of permits for construction which could have an impact on living marine resources. The Corps will continue to make final decisions on issuance of permits.

Comment: Several commenters stated that NMFS should coordinate its habitat conservation programs not just with other elements of NOAA, but also with other key Federal and State agencies which have interests in or responsibilities for habitat conservation

Response: In this regard, NMFS has every expectation of building in other Federal and State agencies. Implementation Strategy No. 6 specifically addresses this concern.

Comment: Suggest development of interagency memorandum between NMFS and the Fish and Wildlife Service, perhaps with Army involved also, to remove duplication of effort when commenting on Corps of Engineers water resource projects and permit applications.

Response: If needed, such a memorandum could be one of many provided for in Implementation Strategy No. 6.

Benefit of Proposed Policy to Other Wildlife

Comment: Recommend inserung at appropriate place, language that states that migratory birds will benefit from policy.

Response: NMFS agrees. Language has been added to reflect that implementation of the policy will be beneficial to other wildlife resources, including migratory birds.

Impact of Energy Development

Comment: Quoting a statement in the Background section that coastal habitats "have been substantially reduced and continue to suffer the adverse effects of . . . energy development . . .," one commenter suggested that unless NMFS could fully document the statement, it should be deleted.

Response: The impacts of energy development on living marine resource habitats were listed along with impacts of other human-related activities such as dredging, filling, coastal construction, pollution and waste disposal. In the case of wetlands, actual loss figures were quoted from *The Coastal Almanac for 1980—The Year of the Coast* (Ringold and Clark, 1980).

Predator-Prey and Ecosystem Relationships

Comment: Recommend adding language that specifically addresses the predator-prey relationship.

Response: The proposed policy implicitly recognized the importance of prey species which support species of importance to man. However, for clarity, the policy has been revised to specifically recognize the importance of the predator-prey relationship by using the language recommended by several of the commenters.

Comment: Several commenters stated that marine life is part of an aquatic ecosystem where food and nutrient sources are so interwoven as to make precise determination of relationships between managed and non-managed species extremely difficult. Proposed policy seems not to provide explicit credence to value of ecosystems in maintaining diversity of species.

Response: The importance of ecosystem planning and research is clearly recognized and dealt with in Implementation Strategies Nos. 1 and 2. This matter is also addressed in the amendment to the policy with respect to the predator-prey relationship.

Funding/Resources

Comment: Several commenters stated that for effective implementation of the policy, an adequate funding base for habitat research and conservation activities must be maintained. Moreover, while delegation of authority to States may be appropriate, lack of money may prevent it from working properly.

Response: Implementation of the policy is not premised upon an increase in funding, but better utilization of funds available. Recognizing that State and local governments also face budget constraints, NMFS expects they will set priorities regarding utilization of resources. The Federal Government will help to the extent it can, such as acting as a catalyst.

Comment: The policy would demand a redirection of NMFS' effort. With no mention of funding for increase in habitat conservation effort, development programs and interests must necessarily diminish as environmental protection programs and emphasis expand.

Response: Although the policy is not intended to significantly diminish specific programs, NMFS cannot forecast the effect on such programs with adoption of the policy. NMFS will deal with the direction of habitat conservation and other activities during its strategic planning efforts.

Research

Comment: Applaud scientific/research thrust, but would like to see requirement for sharing research findings with a variety of non-Federal organizations concerned with habitat conservation.

Response: Implementation Strategy No. 2 has been amended to clearly reflect NMFS' obligation to disseminate information to the public.

Comment: NMFS' role in research activities should receive greater emphasis than is implied in proposed policy statement.

Response: Implementation Strategies Nos. 1, 2 and 3(b) reflect NMFS' desire to give greater emphasis to habitat research activities.

International Habitat Activities

Comment: Regarding NMFS' participation in international habitat activities in support of obligations of the U.S. under international agreements, it occurs that negotiations with foreign nations who are seeking fishing rights in U.S. waters, may offer opportunities for international habitat protection activities. Foreign nations with the best habitat protection records might be given preferential treatment in the fisheries allocation process.

Response: The policy does not preclude this suggestion. NMFS will bring it to the attention of the Department of State with which NMFS cooperates in making allocation determinations. Implementation Strategy No. 6 recognizes the need for interagency cooperation and agreements.

For the reader's benefit, the modified Statement of Policy follows.

Policy Framework

Traditionally, the habitat conservation activities of NMFS have been based primarily on the policies developed in response to the Fish and Wildlife Coordination Act (FWCA) and the National Environmental Policy Act (NEPA). These laws give NMFS an important advisory role, primarily with respect to reviewing and commenting on proposed Federal projects, licenses, permits, etc. which could affect living marine resources. Because of this advisory role, NMFS' habitat conservation activities have been determined largely by the policies, actions, and deadlines of others. For the most part, these activities have dealt primarily with general concerns of habitat loss and degradation and not with specific habitat problems relating to the species of living marine resources for which NMFS has primary management responsibilities, i.e. species (1) covered or subject to being covered under Fishery Management Plans developed under the Magnuson Fishery Conservation and Management Act (Magnuson Act) and (2) assigned to NMFS under the Marine Mammal Protection Act and the Endangered Species Act. Within this framework these activities have been successful in carrying out the objectives of the FWCA and NEPA. However, evolving mission and programs require the Agency to focus its activities on habitats important to the species referred to above.

In addition to the need for a change resulting from the foregoing, a number of events have occurred that give NMFS the opportunity to enhance substantially its overall role in habitat conservation. These include opportunities to use all of NMFS' legislative authorities to take an active role in habitat conservation and to ensure that it is appropriately considered in all of NMFS' programs, and opportunities to make the program more effective through strategic planning. Additional events include changing Federal and State roles under Administration policies and reduced Federal budgets.

Although NMFS' past role in habitat conservation was largely determined by the FWCA and NEPA, significant recent legislation, particularly the Magnuson Act gives NMFS broader authority and more opportunities for achieving habitat conservation objectives. This Act also provides comprehensive authority to integrate habitat conservation throughout the Agency's conservation, management, and development programs. This can be accomplished through the Agency's strategic planning process which is the mechanism for setting priorities based on NMFS' resources and responsibilities.

Changes in traditional Federal and State roles are expected to occur as a result of sorting out responsibilites among Federal, State, and local governments and shifting decisionmaking and responsibility for a variety of policy, budgetary, and regulatory matters to State and local governments. Implementation of this policy will give State and local governments more control over activities that may be more appropriately conducted at those levels and, as a consequence, reduce direct Federal expenditures and involvement.

With respect to living marine resources and their habitats, the sorting out of responsibilities between State and Federal governments is complex. Generally, the States have overall responsibility within their inland and coastal waters (0–3 miles from shore) for management of living marine resources with the exception of marine mammals and endangered species. NMFS has been assigned the Federal management responsibility, in partnership with the Regional Fishery Management Councils, for fishery resources in the U.S. Fishery Conservation Zone (generally 3–200 miles). However, the Magnuson Act recognizes a need for management throughout the range of the species. Moreover, many of the species of living marine resources for which NMFS is responsible spend a portion of their life cycles in habitats primarily located in State waters such as rivers, wetlands, and estuaries. Many of these common property resources cross State as well as international boundaries. Therefore, consistent with the Magnuson Act, NMFS clearly has a role with respect to certain living marine resource habitats located in State, interstate and international waters. NMFS also has a long history of cooperation and interaction with the States on State/Federal fisheries activities under number authorities other than the Magnuson Act.

Policy

Habitat conservation activities will be responsive to the mission and programs of NMFS. The goal of NMFS' habitat conservation activities will be to maintain or enhance the capability of the environment to ensure the survival of marine mammals and endangered species and to maintain fish and shellfish populations which are used, or are important to the survival and/or health of those used, by individuals and industries for both public and private benefits—jobs, recreation, safe and wholesome food and products.

NMFS will direct its habitat conservation activities to assist the Agency in (1) meeting its resource management, conservation, protection, or development responsibilities contained in the Magnuson Fishery Conservation and Management Act, the Marine Mammal Protection Act, and the Endangered Species Act; and (2) carrying out its responsibilities to the U.S. commercial and marine recreational fishing industry, including fishermen, and the States pursuant to programs carried out under other authorities.

Since most of NMFS' programs under its broad mandates are influenced by habitat considerations, habitat conservation will be considered and included in the Agency's decisionmaking in all of its programs. NMFS will bring all of its authorities to bear in habitat conservation. These authorities include those which give NMFS an active, participatory role and those, particularly the Fish and Wildlife Coordination Act, which give NMFS an advisory role.

In carrying out its programs, NMFS' activities will be conducted in a fashion designed to achieve necessary, orderly coastal development in a timely fashion, while the renewability and productivity of the Nation's living marine resources are maintained or, where possible, enhanced. This action will also benefit other wildlife resources, such as migratory birds.

Also, NMFS will use its scientific capabilities to carry out the research necessary to support its habitat conservation objectives.

Implementation

Implementation of the policy will be governed by general Federal policies such as the multiple use of coastal areas. Also, implementation will be governed by the principle that the Federal Government has an obligation to conserve the habitats of living marine resources for which it has primary management responsibility or which are the subject of NMFS program, whether such habitats are under State or Federal jurisdiction. This will require close cooperation and coordination by NMFS with other NOAA elements, Federal and State agencies, the Regional Fishery Management Councils, and the commercial and recreational fishing constituencies. It is particularly important that NMFS and the States work cooperatively to define their respective roles with each directing its habitat conservation activities according to its responsibilities and capabilities.

While this policy emphasizes NMFS' domestic habitat conservation responsibilities, it does not preclude NMFS' participation in international habitat activities in support of obligations of the U.S. under international agreements. International habitat issues will continue to be addressed on a case-by-case basis depending upon the demands of the United States under the provisions of the governing treaty or convention.

Implementation Strategies

In consultation with its Regions and Centers, NMFS' Central Office will prepare guidance for the policy implementation recognizing that each Region has unique resource and/or development issues that require flexibility in addressing particular problems. The following implementation strategies will be used.

1. Each Region, working with the appropriate Center, and the Central Office, will establish a formal planning and coordinating mechanism to implement this policy on a continuing basis. At a minimum, this mechanism will be use to: (1) Identify the living marine resources of importance and the major habitat threats to these resources; (2) enumerate the identified habitat issues in order of priority; (3) develop strategies to address these issues; and (4) oversee the integration of habitat considerations throughout all NMFS' programs. To accomplish the purposes of this planning and coordinating mechanism, NMFS will call on the Assistant Administrators of other elements of NOAA (e.g., Office of Ocean and Coastal Resource Management, Office of Oceanography and Marine Services), the States, the Regional Fishery Management Councils and others, as appropriate. The results of this mechanism will be incorporated into the objectives and subobjectives of NMFS' Strategic Plan as well as the performance contracts of its employees.

2. NMFS Research Centers will conduct environmental and ecological research, including long-term studies necessary to implement this policy. Research efforts will be coordinated with other elements of NOAA (e.g., National Ocean Service), the States and others, as appropriate. Research results will provide an integral part of the informational basis for MNFS' activities related to its conservation, management, protection, and/or development responsibilities. The needs of NMFS' decisionmakers will be the essential consideration in determining research priorities. Specific research objectives and activities will be determined through Regional and Center collaboration using the planning and coordinating mechanism described previously. Dissemination of information to the public is and will remain one of NMFS' major objectives.

3. Since the opportunities afforded by the Magnuson Act are important factors in developing and adopting this policy, in the future NMFS will rely to a greater degree on its partnership with the Regional Fishery Management Councils in habitat conservation as it affects those fisheries subject to Fishery Management Plans developed by the Councils. The Councils provide a unique mix of representatives from the commercial and recreational fishing industries, conservation groups, State and Federal Governments, and the general public. Under this partnership, NMFS will assist the Councils to the extent possible.

(a) The Regional Fishery Management Councils should address habitat considerations in their Fishery Management Plans, where applicable, based on the best available information. While threats to fishery habitat posed by sources other than fishermen are not subject to regulation under the Magnuson Act, an adequate description of the fishery, its maximum sustainable yield, or its optimum yield may require significant discussion of important habitat and threats to it.

At a minimum, Fishery Management Plans should include identification and descriptions of habitat requirements and habitats of the stock(s) comprising the management unit; assessment of the condition of these habitats, to the extent possible, as they relate to the continued abundance and distribution of the species; identification, where possible, of causes of pollution and habitat degradation; description of programs to protect, restore, preserve and enhance the habitat of stock(s) from destruction or degradation; and, where appropriate, proposal of measures intended to preserve, protect, and restore habitat determined to be necessary for the life functions of the stock(s). Failure to describe adequately the condition of the fishery habitat and any likely changes to it may raise questions under several of the national standards and under section 303(a)(1) of the Magnuson Act. Where appropriate, existing Fishery Management plans should be amended to meet these standards.

(b) NMFS must be prepared to respond to the Councils in an agreed upon time when support or information is requested. Section 304(e) of the Magnuson Act authorizes NMFS to acquire the basic knowledge necessary to meet the Councils' needs. Equally important, NMFS will establish a mechanism to systematically consider and follow up on the Councils' recommendations for habitat conservation. If Councils' recommendations are not accepted, NMFS will notify them of the reasons. If Councils' recommendations are accepted, NMFS will adopt them and keep the Councils informed on a continuing basis regarding the results of actions taken to implement the recommendations. If the Secretary does not have the authority to carry out the Councils' recommendations, the Secretary will submit the recommendations to the authorities having jurisdiction over the matter.

4. NMFS will continue to use procedures and options available under the FWCA and other advisory authorities to influence decisions about important habitats identified by NMFS. These activities will include addressing decisions regarding dredge and fill projects, OCS oil and gas development, ocean dumping, water diversion, artificial impoundments, energy facility

siting, water quality degradation, and removal or degradation of tidal and intertidal wetlands.

5. NMFS will work closely with the States, the Interstate Marine Fisheries Commissions, and the Regional Fishery Management Councils to ensure that State/Federal Fishery Management Plans and the Councils' Fishery Management Plans are fully coordinated with regard to living marine resource habitat conservation. This coordination can be served through the Coastal Zone Management, or State/Federal Action plan process which could also provide mechanisms for sharing responsibilities and costs.

6. Since other Federal, State and local agencies are involved in living marine resource habitat matters, NMFS will support existing or new interagency operating arrangements to help define and assign appropriate roles and responsibilities. These arrangements may be informal or formal.

7. NMFS will focus its freshwater habitat activities on anadromous species. This does not preclude NMFS' involvement in a freshwater project if the project could adversely affect living marine resources for which NMFS has primary management responsibility or which are the subject of a NMFS program.

8. Where possible, NMFS will become more actively involved with governmental agencies and private developers during preapplication or early planning stages. This involvement will allow NMFS to better anticipate problems, identify alternatives for achieving objectives, reduce possibility of conflict, and minimize adverse effects on living marine resources and their habitats. In the case of essential public interest projects where practical alternatives are unavailable, NMFS will recommend measures to mitigate habitat losses. Also, when appropriate, NMFS will recommend habitat enhancement measures including rehabilitation.

9. As habitat considerations are integrated across all program lines, each major program office of NMFS will review its authorizing legislation and implementing regulations in conjunction with the Office of General Counsel to determine if these adequately provide for consideration of habitat. Legislative or regulatory changes will be recommended as needed.

10. Recognizing NOAA's broad responsibilities for ocean management, NMFS will continue to cooperate with other NOAA program elements in environmental activities conducted by these elements and will emphasize those activities affecting living marine resources for which NMFS has primary responsibility. NMFS will also seek assistance from other NOAA elements with expertise in areas relating to living marine resources and their habitats.

11. During the implementation of the Federal regulatory reform processes, NMFS, particularly its Central Office, will actively review and participate in the development of evolving Federal and State laws, regulations, policies and actions (e.g., Section 404 of the Clean Water Act) that affect habitats of species for which NMFS has primary management responsibility or which are the subject of a NMFS program to ensure that habitat conservation is appropriately considered.

12. To generate greater interest in perpetuating healthy living marine resource habitats, NMFS will emphasize greater communication of its habitat conservation activities to its constituency. This includes commercial and marine recreational fishing interests, academia, environmental groups, coastal residents, marine-oriented industries, the general public, and the Congress.

Dated: November 21, 1983.

William G. Gordon,

Assistant Administrator for Fisheries, National Marine Fisheries Service.

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Appendix F
NMFS Northeast Environmental Policy

APPROVED AUGUST 29, 198?

ENVIRONMENTAL POLICY of the Northeast Region[1]

POLICY

The Environmental Policy of the Northeast Region, National Marine Fisheries Service, is to minimize adverse effects of man's activities on estuarine and marine habitats by using provisions of the Magnuson Fishery Conservation and Management Act and effective working arrangements with other agencies.

RATIONALE

Purpose and Need

The Regional Policy responds to guidance from NOAA Fisheries that directs the Regions to integrate habitat research and conservation programs into fishery management processes. Congressional leaders have also encouraged NOAA to make a commitment to protect coastal ecosystems and living marine resources. The Policy builds on NOAA Fisheries' Habitat Conservation Policy.[2] and will result in significant benefits to NER's constituents who are interested in a healthy environment, jobs, recreation, and wholesome seafood now and in the future.

In a 15 August 1988 memorandum expressing priorities for NOAA Fisheries, NOAA Assistant Administrator for Fisheries William Brennan stated that "[e]fforts must continue and expand to integrate habitat protection and protected species management into the fishery management process should be the focus of NOAA

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[1]The Northeast Region (NER) of the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS), commonly called NOAA Fisheries, includes the Northeast Fisheries Center.

[2]Habitat Conservation Policy for National Marine Fisheries Service. Federal Register, Vol. 48. No. 228, p.53142-53147, November 25, 1983.

Fisheries' efforts."[3] Recent recommendations of the Congressional Committee on Merchant Marine and Fisheries encourage NOAA to make an increased commitment to its resource management responsibilities to protect coastal ecosystems and living marine resources.[4]

The 1986 amendments to the Magnuson Act also encourage a closer linkage between habitat conservation and fishery management, and add teeth to NOAA Fisheries' habitat conservation program that have heretofore been lacking. Kennedy (1988) summarizes the advantages of the amended Magnuson Act amendments over the Fish and Wildlife Coordination Act (FWCA) and the National Environmental Policy Act (NEPA). The amendments put NOAA Fisheries in a better position to recommend protection for certain areas, as well as the amount of mitigation necessary to compensate for habitat losses[5] The new requirement of federal agencies to provide detailed written responses to inquiries from fishery management councils within 45 days on existing or proposed projects creates a new consultation process that requires more of action agencies than either the Fish and Wildlife Coordination Act or the National Environmental Policy Act. NOAA Fisheries now has a vehicle to address habitat conservation issues on a scale that encompasses overall habitat needs of living marine resources.

Policy Emphasis

This policy addresses all 12 "Implementation Strategies" of the national NOAA Fisheries policy, but increases NER's emphasis on Strategies 3 and 5. Strategy 3 encourages NOAA Fisheries to take greater advantage of opportunities for habitat conservation afforded by the Magnuson Act by establishing stronger partnerships with regional fishery management councils. Strategy 5 advocates using state/federal (e.g., Atlantic States Marine Fisheries Commission, or ASMFC) and council fishery management plans to conserve habitat important to fishery resources.

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[3]Memorandum for Regional, Science, and Office Directors and F/MB Chiefs: "Priorities for NOAA Fisheries." James W. Brennan, Assistant Administrator for Fisheries. 6 pages. 15 August 1988.

[4]U.S. Congress. 1989. Coastal jeopardy: reversing the decline and protecting America's coastal waters. Oversight Report of the Committee on Merchant Marine and Fisheries. Serial No. 100-E. 48 p.

[5]Kennedy, H. 1988. Habitat protection and the Magnuson Fishery Conservation and Management Act Amendments of 1986. Issue 44, Anadromous Fish Law Memo, Natural Resources Law Institute, Lewis and Clark Law School, Portland OR. 13 p.

The regional Policy also strongly emphasizes Strategies 1, 2, 4, and 6 of the national policy; thus, it is a logical step forward in the evolution of the Regional Action Plan (RAP) described in 1985.[6] Strategy 1 directs NOAA Fisheries Regions to establish formal planning and coordinating mechanisms to implement the national policy on a continuing basis. Strategy 2 directs NOAA Fisheries research centers to conduct environmental and ecological research, including long-term studies, that provides scientific information necessary to implement the policy. In general, Strategy 4 advises NOAA Fisheries elements to continue to use procedures and options available under advisory authorities to influence decisions about important habitats. Strategy 6 encourages development of more effective interagency operating arrangements to help define and assign appropriate roles and responsibilities.

In general, the Policy emphasizes using more holistic approaches to evaluate federal permits, licenses, and projects. NER will use provisions of the Magnuson Act and the fishery management process to address the long-term, cumulative adverse effects of habitat degradation caused by man's activities. Future program emphasis will be placed on developing the best possible scientific information to support NER's management recommendations to other agencies. This emphasis takes advantage of opportunities to influence federal regulatory and construction agencies on a broader scale and at a higher level through the fishery management process.

Policy Implications

Successful implementation of the Policy will require significant changes in NER's current working arrangements with outside agencies and organizations. NER cannot abandon its mandated responsibilities under the FWCA and other laws. However, in the face of budgetary restrictions and other constraints, NER must redirect its habitat conservation program to increase long-range benefits in a manner that is consistent with the mission of NOAA Fisheries, rather than dictated by the bureaucratic needs of other agencies. NER will emphasize early involvement in other agencies' plans and activities to avoid or reduce later problems. NER will also continue to search for more efficient and effective ways to fulfill NOAA Fisheries' legal mandates.

Policy implementation will require better definition of major environmental issues and the most significant threats to resources

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[6]Northeast Regional Office & Northeast Fisheries Center, NOAA Fisheries, U.S. Department of Commerce. 1985. Regional Action Plan. NOAA Technical Memorandum NMFS-F/NEC-37. 20 p. + appendices.

in each biogeographic area. Greater coordination between habitat research and conservation programs will result in comprehensive products based on the best scientific information available. NER will use these products to evaluate environmental threats and develop position statements. NER will negotiate more effective interagency agreements and develop improved working arrangements with other agencies. This will allow NER to address environmental issues more comprehensively, rather than on an individual-project, site-specific, and often ad-hoc basis.

Appendix G
1990 Fishery-Habitat-Related Amendments to the Magnuson Act

MAGNUSON FCMA REAUTHORIZARTION AMENDMENTS
PERTAINING TO HABITAT CONSERVATION.

The Magnuson Fishery Conservation and Management Act (Public Law 94-265) as amended through November 28, 1990 re-affirmed that conservation and management applied to both the fishery resources and the marine environment, and provided the Councils with specific duties to identify and conserve fishery habitat. The pertinent sections are quoted as follows:

SEC. 3. DEFINITIONS

(2) The term "conservation and management" refers to all of the rules, regulations, conditions, methods, and other measures (A) which are required to rebuild, restore, or maintain, and which are useful in rebuilding, restoring, or maintaining, **any fishery resource and the marine environment**; and (B) which are designed to assure that--

(i) a supply of food and other products may be taken, and that recreational benefits may be obtained, on a continuing basis;
(ii) **irreversible or long term adverse effects on fishery resources and the marine environment are avoided;** and
(iii) there will be a multiplicity of options available with respect to future uses of these resources.

SEC. 302. REGIONAL FISHERY MANAGEMENT COUNCILS

(i) FISHERY HABITAT CONCERNS

(1) Each Council--

(A) **may comment on and make recommendations concerning any activity undertaken, or proposed to be undertaken, by any State or Federal agency that, in the view of the Council, may affect the habitat of a fishery resource under its jurisdiction** and (B) **shall comment on and make recommendations concerning any such activity that, in the view of the Council, is likely to substantially affect the habitat of an anadromous fishery resource under its jurisdiction.**

(2) Within 45 days after receiving a comment or recommendation under paragraph (1) from a Council, a Federal agency shall provide a detailed response, in writing, to the Council regarding the matter. In the case of a comment or recommendation under paragraph (1)(B), the response shall include a description of measures being considered by the agency for mitigating or offsetting the impact of the activity on such habitat.

SEC. 303. CONTENTS OF FISHERY MANAGEMENT PLANS

(a) Required Provisions.--Any fishery management plan which is prepared by any Council, or by the Secretary, with respect to any fishery, shall--

(7) **include readily available information regarding the significance of habitat to the fishery and assessment as to the effects which changes to that habitat may have upon the fishery;**

SEC. 304. ACTION BY THE SECRETARY

(e) FISHERIES RESEARCH

(2) The areas of research referred to in paragraph (1) are as follows:

(A) Research to support fishery conservation and management, including research on the economics of fisheries and biological research concerning the interdependence of fisheries or stocks of fish, **the impact of pollution on populations of fish, the impact of wetland and estuarine degradation,** and other matters bearing upon the abundance and availability of fish.

Appendix H
Environmental Quality and Resource Health -- Quantifying Resource Loss

Environmental Quality and Resource Health - Quantifying Resource Loss

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for
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INTRODUCTION

There is no doubt that the future of fisheries, as well as fisheries research and management, will change drastically in coming decades as the 21st Century commences. Declining stocks of fishes necessary to sustain a healthy industry will have to be dealt with. Numerous developments in the field of recreational fisheries will also mean that there will be a greater competition for any remaining wildstocks. Changes in dietary habits of the American citizenry will also affect our uses of the wild fish stocks; increased seafood consumption for purposes of gourmet meals, or for reasons of health, will undoubtedly lead to an ever increasing consumption of seafood among the general citizenry, as well as by selected portions of the population. Changes in attitudes of the US Government and the national business community will also mandate that the United States attempt to become an exporter of seafoods rather than a net importer.

At the same time as these changes are occurring, there will be change in the ways that fossil fuels are used in this country; while shortages of fossil fuel energy have not affected the operation of fisheries vessels to date, there is little doubt that sometime in the near future greater attention will be paid to fixed gear and other low energy ways of fishing. Most important to our meeting today, to meet the nation's needs for seafood a far greater effort will be made to protect coastal and shelf habitats. Mariculture operations cannot be conducted in waters that are even marginally contaminated, and mariculture activities tend to produce their own unique forms of contaminants. Given the changing nature of the fisheries in the United States, far more attention will have to be given to habitat quality and how to manage the coastal zone in the future, including principal harbors, estuaries, coastal waters, and riverine systems which drain terrestrial habitats far removed from the sea.

Fisheries habitat research to date has been naive, as have our attempts to "manage" the habitat necessary to the reproduction, recruitment, and growth of fin and shellfishes.

Marine scientists studying environmental issues have tended to carry out research which did not address the real issues at hand; often little regard was paid to the **cumulative effects** of man's activities (Dayton, 1986; Dickert and Tuttle, 1985; Waldichuk, 1986). Physical degradation and its effects have become intertwined with the chemical effects of toxins and nutrients, often leading to conditions such as those found in Boston Harbor and the New York Bight. More important, even the best of our reports ("grey literature") and peer reviewed publications "get lost" in the voluminous compilations of the environmental literature; a review of **any** issue of the UK Marine Pollution Research Titles indicates the depth of the problem. Finally, marine environmental scientists have persisted in addressing each other, and rarely has this community conveyed its findings to the real managers - the municipal and county governments, urban planners and zoning officials, and politicians, and their constituencies - the body public. Thus the coastal zone and principal fisheries habitats have slowly slid under a sea of asphalt - lost forever to the fishes which depend upon them. To reverse these trends, aquatic scientists must begin to address the issues so that 1) the cumulative effects of man's activities are understood, 2) the voluminous data and publications are integrated and synthesized to some greater whole, and 3) the results of such analyses are conveyed to those persons and institutions responsible for development and other uses of the coastal zone. We must begin to take the awesome responsibility to establish **standards** and **criteria** necessary to the management of the coastal zone for the betterment of fisheries habitats. This can best be done in the same vein as by the public health and preventative medicine communities. More research and quantification are not the sole answers to improved fisheries habitat. I hope the following thoughts will help us to move in the right directions.

CURRENT ISSUES

In the past much of the concern of the Northeast Region of the National Marine Fisheries Service has been for the commercial fisheries which tended to occur further offshore and in areas such as Georges Bank, far removed from sources of pollution. While the Agency had some concern for recreational fish, by and large these activities were not of great concern and tended to be activities which occurred within the coastal zone and principal embayments of the Northeast; such habitats are often under the aegis of states. In recent years, however, recreational fishing has increased significantly in urban areas as well as along the less developed areas of the Northeast coastline. Heatwole and West (1985) discussed the sociological and economic aspects of recreational fishing, providing as a case study information on

fishing activities within the bounds of New York City. At the time they wrote their paper, they indicated an interest in pollution effects and how these might affect the outlook towards recreational fishing. Poulin and Haynes (1986) reviewed the various development activities and forms of environmental impacts that affected recreational activities on the Great Lakes, including fishing. Most of their concerns are applicable to marine waters. They raised certain critical questions such as, should coastal areas be further developed, and, if so, how should development occur so as to maximize recreational benefits while minimizing environmental degradation and other negative aspects? They attempted to address issues such as are coastal environments (wetlands) so ecologically important as to recommend no recreational activities for such areas? Following on such reports and information, the National Oceanic and Atmospheric Administration (NOAA), in its Coastal Zone Management Information Exchange documents, has pointed out significant issues in relation to the future management of the coastal zone and marine resources. Issues such as non-point sources were seen as extremely important in the development and utilization of renewable and nonrenewable resources within the coastal zone (NOAA, 1991).

One of the first steps required in managing the coastal zone, to the degree that living marine resources and their habitats are not compromised, is the development of a land use and land classification document which provides standards for land use and developmental activities within the coastal zone. Classification typically involves several phases (Baker, 1985), the first of which is usually a rather gross level of description for coastal areas. As an example, Baker (1985) included rankings such as Level I, 1. **Urban or Built Up Land**; Level I, 2. **Agriculture Land**; etc. These level I categories can then be divided into more precise or refined classifications. For instance under Level I, 1., Urban or Built Up Land, the classifier broke this category into 1.1, **residential**; 1.2, **commercial and services**; 1.3, **industrial**; 1.4,**transportation/communications**; etc. These second level classifications can then be further broken out, i.e., 1.2, commercial and services, into 1.2.1, **motels and hotels**; 1.2.3, **marinas/docks/boat storage facilities**; 1.2.7, **parking lots**; and 1.2.9, **commercial/service areas partially developed**; etc. The standard procedures for proceeding with such classification are given in Baker (1985). Such classification can be related to aerial photographs or LANDSAT satellite imagery. Where states have accomplished such surveys and classifications, it is now possible to detect the changes which occur in an area as it is being developed.

The second key phase for any classification endeavor is to develop information on the status of the habitats themselves, i.e., the estuaries, wetlands, and sublittoral environments of interest to managers. The U.S. Department of the Interior (DOI),

Biological Services Program, implemented such a classification scheme well over a decade ago. Based upon several national interagency meetings, the original protocols were developed and promulgated widely. Basically the DOI scheme involved major ecological systems such as **marine, estuarine, riverine**, and **lacustrine.** The marine and estuarine systems had subsystems headed **subtidal** and **intertidal.** Within subsystems, classes were established based on substrate material and vegetative life forms. For instance intertidal areas could be described as having rock bottom consisting of bedrock, boulders or stones, or any one of five other classes such as unconsolidated bottom or unconsolidated shore or reefs. Vegetation was used to define the vegetative components and included categories such as aquatic beds, emerging wetlands, shrub-scrub wetlands, etc. This classification system was described by Cowardian et al. (1979). Again, the classification scheme lends itself to aerial photography as well as to certain remote sensing efforts using satellites. The DOI began a program to classify wetlands throughout the United States; again, details are described in Cowardian (1979).

In addition to developing classifications of coastal wetlands, and coastal zone and riverine situations leading to coastal habitats, the DOI felt it was important to develop **species profiles** for key marine fishes and invertebrates. The species profiles presented brief life histories and "environmental requirements" of key species (for instance, see Fay et al, 1983). The DOI believes that by evaluating the present status of habitats (habitat classification) it becomes possible to relate the environmental requirements of important coastal fishes and invertebrates to such habitats. In theory this is a good concept but it is one that **must** be improved upon. The environmental or habitat requirements of any fish, even relatively sedentary forms such as the flounders, can be extremely complex, often involving hundreds of variables. To determine the fitness of a habitat to accommodate the needs or requirements of a fish species, it is necessary to understand these variables and the numerous subtle **cues** and arcane **couplings** which exist between resource species, their physical habits, and each other, as well as the biota they depend on for forage or shelter.

Beyond looking at the classifications of habitat uses, and of wetlands and coastal waters, according to certain vegetative or physical characteristics, NOAA has recently developed a report on a proposed classification system based on analyses of salinities preferred by a range of marine species (Bulger, et al., 1990). The classification was conducted after data were complied and analyzed on the reported salinity ranges of 370 species and life-history combinations. The work is apropos salinity variation in the Mid-Atlantic region and resulted in five somewhat overlapping salinity zones. Such information will

be of general use, but will be particularly important where salinity profiles change with rainfall, drought, increasing sea levels or land subsidence, and interactions between salinity and contaminant effects. Again, such classification of chemical and physical variables is paramount to establishing the habitat requirements of a range of marine fish and invertebrates.

Based on the DOI, Fish and Wildlife Service (FWS) National Wetlands Inventory Program, NOAA has recently commenced drawing together information that is compiled into the National Estuarine Inventory (NEI). The first NEI, "Coastal Wetlands - New England Region", brings together information having to do with estuaries and wetlands from Connecticut to the Canadian border. This NEI gives information on the percent of each total county area that is defined as wetlands. Moreover, it is a good example of the use of certain historical information (i.e., the FWS National Wetland Inventory). By providing depictions of available wetlands within each major region, and providing a base for understanding the characteristics of the wetlands and estuaries within these regions, it becomes possible to relate habitat needs of marine fish and inverterbrates to **available** habitat. Beyond this, changes in the quantity (acres) of wetlands within the area can be quickly assessed by doing periodic updates of the information. We already know that some 90% of the coastal wetlands in California have been lost, and that more than 50% of the coastal wetlands in Louisiana and Connecticut have been degraded in some way that eliminates them as a functional part of a national or regional estuarine system.

By having the inventories of estuarine habitats available, researchers can, in the future, look at more specific conditions **within** local estuaries. For instance Thayer and Chester (1989) have recently considered basins and channels as habitat for a range of fisheries in Florida Bay. These authors determined that the channels within the Bay support a higher diversity of fish. Moreover, channel areas generally displayed the greatest overall standing stocks and densities of sea grasses. By conducting analyses of the distribution and the abundance of finfish, and their life history stages, it is now known that these specific subsystems provide habitat for pre-recruits (larvae and juveniles) and also provide luxuriant populations of forage species relative to higher salinity habitats. It is also known that a range of alterations are rapidly impacting on marine fisheries populations and communities (Colby, et al., 1985) within these habitats.

Other authors (Dawes, et al., 1985) have studied specifically the sea grass communities in comparable habitats throughout Florida. They measured the seasonal biomass and energy content inherent in sea grass communities and have begun to make calculations as to the production of forage available as food to fishes, invertebrates, and their various developmental

stages and instars. Interestingly, these authors give findings that conform with work done by other authors, suggesting a high degree of uniformity between populations of turtle grass, Thalassia testudinum, a key vegetation component. They note that seasonal fluctuations have been determined; these undoubtedly are related to evolutionary development of reproduction and recruitment during specific times of the year. In seven sea grass communities sampled along the west coast of Florida, biomass was highest in the spring and summer. Although the lowest periods for standing stocks of macroalgae were in the mid-winter months, kilocaloric values remained high at most sites throughout the year, inspite of winter dieback. Thus macroalgae, along with sea grasses, can provide available kilocalories, and energy, throughout the year. The narrative on the last five or six pages of this paper suggests to this author that the classification process can become evermore complex, going from generalizations about land use to conditions of habitat and their relation to fishes.

COUPLING, CUES, and LOOPS

Given the foregoing, that the nature and quality of marine habitats vary considerably throughout the coastal areas of northeastern United States, and that there are specific habitat needs that must be met if optimal reproduction, recruitment, and growth are to occur, it is then important to know what the connections might be between the more important habitat variables and the biology, or life history, of key species. Weekly, I have received several score of journals or reprints which deal with marine sciences generally, and fisheries science in particular. The journal articles and separates regularly touch on seemingly arcane, eclectic subjects and issues, which, at first glance, have little to do with the biology of fishes or the status of their habitats. Thus they may be rapidly put aside in lieu of more interesting reading; the fact is, however, that many of these articles have an **overwhelming appropriateness** for the subjects at hand. For instance, a recent study (Starr, et al., 1990) has shown that there is a coupling of spawning of marine invertebrates and the onset of phytoplankton blooms. Spawning in the green sea urchin, Strongylocentrotus droebachiensis, and the common blue mussel, Mytilus edulis, seems to be fostered by metabolites released by several species of phytoplankton. As phytoplankton "peak" they apparently produce metabolic byproducts which form a **cue** inducing spawning by the urchin and mussel. The seminal thought here is that the integration of several abiotic and biotic factors (inherent in any definition of habitat quality) leads to plankton blooms, spawning, and subsequent favorable conditions for larval growth and survival. Numerous authors have reviewed the evolutionary significance of this and report that similar direct **coupling** of reproduction and larval growth phases with phytoplankton blooms is common among a range

of marine invertebrates. In tandem, the larvae, early juveniles, and adult stages of the meroplankton, as well as the holoplankton, provide food stuff to juvenile fish and filter feeders.

Related to the coordination of plankton blooms and spawning, it has been noted that diel movements of zooplankton organisms above certain substrata (reefs) occur in a way so that these (organisms depending of their life history strategies) are available in part for planktivorous fishes, but also as a strategy to prevent loss of plankton from key habitat essential to their survival (Hobson and Chess, 1986). Depending on ambient light, the generally larger forms of zooplankton tend to be local residents that, by day, are sheltered, or hidden, in bottom substrata or as swarms close to the substrata, but, at night make excursions to the surface waters to feed. Transients in this system are mostly holoplankters, including certain copepods, euphausids, and chaetognaths; these open water transients, brought by current systems to the reef areas, function in the water column at night to a great degree to supply food to predator finfishes. The key point in the work by Hobson and Chess is that temporal variations in light intensity foster behaviors which facilitate feeding by fish but also survival for certain of the planktonic organisms. Again, the light cues were, in part, mediated by the physical conditions (ambient light) but also may be modified by other conditions such as turbidity or currents. The latter can be affected by man's activities.

In addition to physical cues that might lead to behavioral changes, including diel movements, or might result in changes in feeding (concentration of predators and forage species by current systems), **chemical cues** may foster or inhibit feeding. For instance, zooplankton, including copepods, have been observed to graze on red tide organisms that are unique to their particular habitats. The red tide species, Ptychodiscus brevis, has been speculated possibly to inhibit feeding or to perhaps induce paralysis or other physiological incapacitation of predator copepods, when this red tide phytoplankton species is ingested. Turner and Tester (1989) noted that three copepod species ingested the cells of Ptychodiscus in direct proportion to their availability over a broad range of cell concentrations. On the other hand, two copepod species either did not ingest, or ingested only a small number of cells, at similar concentrations. Thus there is a selection depending on species. This information is important not only in relation to "red tide" phenomena but also suggests that the qualities of habitats can affect feeding and thus indirectly, reproduction, recruitment, and growth. The work reported was done was off the Carolinas, and during a period when P. brevis bloomed in unusual proportions in a "foreign" environment. The authors saw it as noteworthy that the three copepod species that ingested the P. brevis were all forms which share similar coastal waters in the Gulf of Mexico, which also constitutes the principal range of P. brevis.

Another form of coupling, that of predator and prey, is being modeled by numerous workers. Katz, et al. (1991) has modeled and compared the outcomes of nonlethal and lethal foraging on the persistence of predator-prey relations. In lethal foraging the predator consumes entire individuals, and thus has a potential to eliminate the prey species individual, as well as entire populations. If there is a sufficient level of predation, the population that constitutes the forage species can be lost from the system. In non-lethal predation, the prey species may feed upon tentacles, siphons, and other exposed tissues of a range of invertebrate and vertebrate organisms. Where non-lethal predation occurs, the predator population may be sustained for extended periods of time without the principal forage species being eliminated. This is especially true where tissues may grow rapidly, thus replacing the tissues, organelles, or collective body parts that were lost due to the predation.

Non-lethal foraging, a widely distributed phenomena in marine habitats, is an important aspect in understanding quantitative effects of contaminants or environmental degradation in marine habitats. Obviously if organisms can forage without killing off, in the classic sense (the lynx-hare relationship), their forage species, the system can be sustained for extended periods. The relevance of this work to our present interests is that the interactions between predators and their prey are complex and can change with time, especially where prey may be consumed via lethal foraging. As pressures on such prey develop, contaminants or environmental degradation may shift the success of the predator population in a way such that there are decreases in key prey stocks; those predators which feed or forage in a non-lethal fashion may, with the added consequences of habitat degradation, be placed in a situation where the prey tissues that provide sustenance simply do not regrow at the same rates as in a non-perturbed system.

It has been demonstrated in a number of experimental situations that many bottom-dwelling invertebrates, which serve as principal forage for marine groundfish, are affected by relatively simply changes within the physical environment. For example, in recent experiments done with excised gill tissue from the scallop, Pecten novaezelandiae, certain tissue activities responded to different categories of suspended silt (Stevens, 1987 and 1988). His study suggested that juvenile scallops (20 mm shell height) are less tolerant of suspended silt than larger (70 mm shell height), and that both small and large scallops have reduced tolerance to fine moieties of silt/clay (less than 10 μm). Conclusions from his experiments suggested that increasing concentrations of silt with decreased particle size would result in decreased efficiency and increased mortality rates of whole scallops. This suggests that human induced disturbance of bottom sediments, such as occurs with bottom trawling and dredging, may affect scallop and other invertebrate populations dependent upon

ciliary modes of feeding. Again, the "loops" back to lethal and sublethal foraging are obvious; if key forage species are lost due to anthropogenic activities, the general system loses stability, with significantly greater losses in those species conducting lethal foraging.

MORE COUPLINGS, CUES, and LOOPS

In recent decades it has been fashionable to challenge marine organisms with a range of contaminants including trace metals, chlorinated hydrocarbons, petroleum hydrocarbons, and other toxic contaminants. In many cases the individual fish or invertebrate is observed and the time taken for the organism to die, or show a significant change due to increasing concentrations of a contaminant, are measured and a LD50 assessed. Rarely was any attempt made to relate the findings to the status of stocks or reduced productivity. More recent studies have considered the accumulation of certain contaminants as they might move through a natural or artificial foodweb. Rubinstein, et al. (1984) conducted a study of the uptake of PCBs from a contaminated sediment via a polychaete worm which is a principal forage species for a fish, the spot. The results of these studies indicated that contaminated harbor sediments can serve as a source of PCBs which will accumulate throughout varying elements of the foodchain, including sandworms and spot. This is an important observation since PCBs are relatively insoluble in water but are associated with organic moieties in enriched sediments. Thus as worms ingest sediments, supposedly toxic PCBs can be concentrated in their tissues, to be passed up to those species of fish which forage on the worm either lethally or non-lethally.

The uptake of organics and inorganics (toxic trace metals) is reasonably well known and there are literally hundreds of papers that give data on the body burdens of contaminants. One such paper (Boehm and Hirtzer, 1982) provides information on levels of petroleum hydrocarbons in several species of finfish which habituate the Gulf of Maine and Georges Bank. Interestingly it is not until trawling (sampling) stations were located over the Scotian Shelf that samples of fish, free of petroleum and PCB, were recovered. Similar measurements and reports of tissue levels of contaminants have been made for a wide-range of habitats. For instance, fish from Puget Sound have been found to be contaminated with various organic contaminants (Konasewich, et al, 1982). Beyond this, fish from habitats heavily contaminated with organic substances have been reported to have elevated tissue levels of contaminants and a significant incidence of disease syndromes (Malins, et al, 1982). Similar information and data for the Northeast are, unfortunately, fairly scarce. While there have been a number of studies which show exceptional levels of PCBs, petroleum hydrocarbons, and other contaminants, there

are relatively few data which suggest a cause and effect, i.e., that fish with larger burdens of organic contaminants show increased incidence of disease or other anomolies. Beyond all this, such data are often in the category of being **irrelevant** to the management of fish stocks; as with human populations, the effective manager does not want to wait until contaminant levels build to elevated readings and the species manifest disease or other abnormalities. Ideally if one is managing coastal environments, one would want to be aware of slight increases in contaminants in the environment, and then the results of measurements of **subtle cues**, i.e., changes in behavior. This allows for corrective steps to be taken before environments are "loaded" with a particular contaminate, or set of contaminants, and before fish begin to show exceptional changes in biology or pathology.

Given this, **what are the cues that one might look for?** Among the various cues that can be disrupted are those which are associated with settling of larvae and recruitment to appropriate environments. By appropriate environments, it is understood that the fish or invertebrates would settle, metamorphose, and develop in those environments which would be suitable for the adult stages, or instars, and which would provide the necessary nutrients for growth and subsequent reproduction. For instance, Butler and Herrnkind (1991) recently conducted experimental work to determine how certain benthic microhabitat cues might influence the metamorphosis of larvae of spiny lobsters. They based their experimental approach on numerous studies which have been done in the past and which have to do with cues that result in appropriate behavior patterns for settlement of a range of larvae. The classic work by D. P. Wilson (1953) provides the basis for such understanding. In the case of the spiny lobster, earlier work has suggested that larvae most appropriately would settle on or amongst "suitable algae." Larvae that do not contact a suitable substrata can be hypothesized to be forced by imminent metamorphosis to choose other microhabitats where their morphology, cryptic coloration, and behavior will not be satisfactory, allowing them to fall prey to fish and invertebrate predators. The question arises, what are the effects of organic contaminants on such recruitment processes? Pearson, et al (1981) reported on how petroleum in the ambient environment (both experimental and natural habitats) influenced certain behavioral responses of crustaceans. Their work suggested that in the presence of elevated amounts of petroleum hydrocarbons, inappropriate behavior and behavioral responses, inimicable to survival, do occur.

Another area of interest in these regards has to do with the specificity of host recognition or habitat recognition of individual symbiotic organisms. For instance, it has been well demonstrated that symbiotic pea crabs of the family Pinnotheridae are often host specific; at a particular stage of development

(usually an early instar) these parasitic crabs find their way into appropriate bivalve or tunicate hosts. If they do not occupy the definitive host, they generally perish. Recent work done in New Zealand again suggests that this is, in fact, the case. Moreover where populations of a pinnotherid species occupy two different hosts, for instance the green-lip and blue mussels, they have been determined to represent different "host races" (subspecies), a conclusion "supported by the degree of genetic differentiation between" the two subspecies (Stevens, 1990). Once more, one raises the question of how this relates to marine fishes? The fact is that many fish, but especially the anadromous salmonids, do orient to certain cues coming from **appropriate** habitats. Much of the life history of these fish is tied to such cues. Research done recently by Pearson, et al, (1990) suggests that cues within the environment will lead teleosts to home ranges, habitats, or hosts not appropriate for normal growth and survival. Obviously, when fish do not occupy the appropriate environment, various disruptions of energetic schemes and behavioral loops or connections are affected; organic contaminants can interfere with such loops.

Hundreds of investigators also have determined that feeding activities are carried out by subtle cues provided by the forage species or foodstuffs. Laboratory research suggests that often these cues can be "swamped" by foreign substances, or cues, from contaminants in the environment. There are scores, hundreds, of papers on this subject.

COVERUPS AND FOOTSTEPS

In addition to pollutants affecting cues important in normal behavior of marine organisms, other endogenous phenomena may affect, or reflect, how animals deal with a range of toxic substances. For instance, marine organisms stressed by toxic metals may invoke the use of low molecular weight, metal binding proteins often referred to as metallothioneins. Considerable work has been done with this group of proteins in the sense that their presence reflects exposure to and uptake of toxic metals; the metallothioneins often function to sequester metals in a way that will prevent their harming essential physiological and biochemical processes in the exposed individual. These are real **coverups**. By measuring the metallothioneins, however, one can get an indication of the exposure to contaminants and even assess the degree of exposure. Such analyses point to **footsteps** left by the presence of metals, even where the latter are not to be found. Recently NMFS scientists (Engel, 1988) have done work to determine how much biological variability there might be in metallothionein responses, especially as the responses are being used in long-term monitoring programs. As time and tide wait for no man, time of year, or the condition of the organism, may affect the operation of metallothionein sequestering systems; for

instance in bivalves, e.g., the oyster, it is necessary to understand fully how seasonal cycles come to bear on the organism and may influence total metal concentrations in the animals, as well as the patent nature of the metallothioneining response. In certain decapod crustaceans, the blue crab, total metal concentrations have been shown to be significantly altered by the moult cycle which most decapods pass through on a seasonal basis. Environmental managers, that are assessing the information forthcoming from long-term biological effects monitoring, must be aware of such variability, especially as it may be induced by seasonal (exogenous) phenomena or by endogenous rhythms that are inherent in day-to-day physiological activities, growth, and reproduction.

From the foregoing, it is obviously important to look at responses of organisms seasonally (Munro, et al, 1990). This suggests that scientists, developing information on environmental effects, must be cautious in interpreting data in the sense that time may profoundly alter responses.

All of the foregoing narrative has tended to be concerned with the issue of contaminants in the environment. This is appropriate since much of the concern of present day environmentalists and fishery habitat managers has been related to the status of contaminants in coastal waters. Another area of considerable concern, however, has to do with the disruption of conditions such that wetlands, riparian situations, and other aquatic habitats, of importance to marine organisms, are despoiled in some way. Literally hundreds of papers have been written in regard to the possible effects of dredging, spoiling, bulkheading, and other activities associated with the development of coastal areas and ports and harbors. In many instances such physical degradation is tied closely to contaminants; highly contaminated harbor sediments may be dredged to deepen channels and taken offshore or to other harbor areas for disposal. There has been a high level of supposition that these "introduced contaminants" may be environmentally harmful to the areas to which they are taken. There have been mechanisms, e.g., the **capping** of contaminated dredged materials, recommended for preventing the spread of habitat contaminants via physical development in the environment (Bokuniewicz, 1983). Extensive work has been done using side scan SONAR and precision bathymetry to develop the "footprints" that result when solid wastes are disposed of at sea, and thus provide a basis for physical coverups.

Very recently, marine scientists have begun to look at the consequences of relatively minor development or even the effects of human footprints. Liddle (1991) has authored a paper in which he previews the relatively extensive literature having to do with human "trampling" on vegetation and coral reefs. Ecologists concerned with recreational uses of coral reefs have seen that

the same principles used in the study of trampling of plants can be applied to corals, and probably to those coastal wetlands which are increasingly being used for recreational and commercial purposes. For instance, the coral reefs found along the northern and eastern shores of Australia are used heavily by recreational divers as well as individuals collecting "precious" corals. Scientists are attempting to provide a means of predicting the resilience of extensive coral communities to varying levels of use, and even the sole presence of man. The first approach is to determine where the "footprints" occur, how "large" they are, and how much damage to marine fisheries habitats they truly constitute. Again, footprints may ultimately have something to do with cues and changes in cues, and such footprints should quantified both from a spatial point-of-view as well as a chemical one.

Cues, loops, and footprints are all phenomena that can be well understood intuitively. Generally the footprint phenomena will exist in two dimensions and might be "palpable" by visual and gustatory senses. Other phenomena will, however, exist in three dimensional planes and thus be even more difficult to assess and comprehend.

CLOUDS

One such phenomena has to do with the distribution and abundance of plankton through the three dimensions characteristic of coastal waters. Since the beginnings of marine biology scientists have been interested in defining such waters. At one time the only way to do this was through the use of nets that were lowered through the water column to retrieve samples from imprecisely known depths. Later, scientists developed opening and closing nets which allowed samples to be taken from exact depths. Still, however, the scientist had to work from hundreds of samples to develop a three dimensional picture of plankton distribution and abundance. Besides the three usual dimensions, scientists soon learned that planktonic organisms are ephemeral. Large masses of plankton will quickly move into, through, and out of a particular sampling area. In addition to this, many forms of planktonic organisms bloom inexplicably; whereas yesterday there were only a few cells of a phytoplankton species, or a few individuals constituting a copepod population, tomorrow there might be millions of such cells or organisms. These life forms are constantly subject to the vagaries of the physical and chemical environments and thus depend upon sudden changes in the water column itself for successful production. Today, individuals that are concerned about marine pollution are very concerned about plankton populations. As noted, however, the sudden comings and goings of these organisms generally make it difficult to assess them from the point-of-view of contaminant uptake or physical degradation properties. What we now know,

however, is that certain species of phytoplankton may suddenly bloom out of all normal proportion to their partners who share their ambient environment. Species of phytoplankton in coastal waters will suddenly go from a few cells per hundred milliliters, to tens of thousands or even hundreds of thousands of individuals. In warmer, shallower waters such cells quickly use all available nutrients and literally starve to death; when this occurs bacteria rapidly attack the individual cells, in many cases using up the available oxygen in the particular water mass. This results in a set of circumstances in which plankton blooms occur as a result of **eutrophication**, to be followed by **hypoxia** or **anoxia.**

Some clouds are colored. The so-called "red tides" really represent clouds of toxic phytoplankton cells existing within a particular water mass. Again, it is erroneously thought that such clouds of toxic organisms always reflect the activities of man; it has been hypothesized, however, that man is today releasing far more nutrient materials to coastal waters resulting in eutrophication and plankton blooms. Nutrients induce the blooming of phytoplankton organisms which then grow out of proportion to their peers in the environment, leading to a situation where, when fed upon by invertebrates or fish, they may render the tissues of the latter toxic for human consumption. In many instances, the red tides that are toxic are not actually red but may be green, blue-green, orange, or other colors. The important thing is that if, in fact, man is continually adding more nutrients via agrarian situations, urban lawns, or open discharge of sewage, he (she) is fostering inevitable increases in red tide blooms; such clouds are not necessarily "cloudy". Marine scientists have considerable understanding of the factors that result in the development of red tides, toxic phytoplankton blooms, and similar phenomena. Scores of international conferences and symposia have been held and there are significant data sets and information to allow marine scientists to assess the situation. What is presently needed in the Northeast is a statement as to how wide-spread the phenomena is, what are its overt, and potential significances to the fisheries and habitat quality, and how should these situations be mitigated? We know from recent events in southern coastal waters, that certain red tide phenomena, a bloom of Ptychodiscus brevis, occurred along the North Carolina coast under rather unusual situations. Between November 1, 1987 and January 21, 1988 a total of 145,000 hectares of approved shellfishing harvesting waters were closed during this period. This affected 50% of the oyster and 98% of the hardshell clam harvesting areas. Apparently "seed populations" of this red tide species were carried from the Gulf of Mexico around Florida to coastal areas off the Carolinas. There they experienced an exposure to nutrient rich waters which caused them to bloom, thus affecting large areas normally dedicated to the shellfisheries.

A very interesting sidelight to the issue is, again, a temporal one. Recent research (Reinfelder and Fisher, 1991) indicates that zooplankters, such as copepods, have short gut residence times and a digestive strategy that allows only for the assimilation of soluble materials. Copepods feeding on senescent cells with great amounts of moribund materials should be able to obtain more proteins (algal toxins?), than from rapidly dividing cells. Thus, success or "evil" might be bridged to synchrony of blooms of phytoplanters and copepods and the relative length and efficacy of their digestive tracts.

HOW TO GET THERE FROM HERE?

The subject of my talk was entitled "Environmental Quality and Resource Health - Quantifying Resource Loss." In what might appear, to some, to be an unguided wandering through a morass of papers and subjects, I have tried to point out a number of the biological variables that will be important in the future in terms of understanding those biological processes that govern distributions and abundances of marine fishes and shellfish. This narrative reflects a small sampling of the literally thousands of papers having to do with various aspects of marine biology, pollution, and the associated fisheries, appearing each month. The important point is that there are so many variables which can be affected by man's activities that it would be impossible to fold each of them into some "model" that might moderately reflect how a particular fisheries would develop under a given set of conditions. The natural physical conditions in themselves can vary considerably albeit we can put error bars and ranges on most physical measurements having to do with fishery habitat. Once we begin to consider, however, the interactions that occur between the hundreds or thousands of species of biota that are involved in the foodwebs of the principal fish, or what goes on in a diatom cell or copepod gut, and attempt to factor in the various variables having to do with man's activities, the entire picture becomes extremely clouded.

Many people have thought about this at great length. The International Council for the Exploration of the Sea (ICES) meetings on biological effects monitoring (McIntyre and Pearce, 1980) tried to elicit from a range of experts what the more important biological parameters might be that could be used in monitoring endeavors. Other national and international workshops have attempted to do the same thing (Malins, et al., 1988). Beginning in the past two decades, it has been fashionable to believe that chemical and physical variables might be relatable to various disease syndromes that manifest themselves in fish populations under stress (Malins, et al, 1982). Others, particularly physiologists and biochemists, believe that it might be possible to relate chemical and certain physical changes in fisheries habitats to changes in the physiology and biochemistry

of fish (Konasewich, et al., 1982 and Chapman, et al., 1982). The presence of metallothioneins for instance might be an indicator of stress due to toxic metals (Engel, 1988).

I personally remain convinced that we should look at measurable changes in the quality of marine habitats and, based on laboratory and field experiments, relate such changes to classifications, standards, and criteria that are developed in the same way as used in public health programs. For instance, as we see increases in bacteria and other microorganisms, i.e., geofungi, in the environment we can easily apply standards that would relate to fish, as well as to public health. Likewise, where habitats are significantly affected by organic contaminants or by toxic trace metals, standards can be developed for contaminant levels in ambient environments, as well as for levels in the tissues of fishes. There are sufficient written materials on these subjects to allow us to begin this process now. In fact, some years ago the U.S. EPA commissioned a review of the "EPA Redbook: Quality Criteria for Water." This effort was undertaken by the Water Quality Section, American Fisheries Society (Thurston, 1979). This effort should be revisited and the Redbook updated to a point where it will be accepted by the larger fishery research community, as well as by the general environmental community concerned with long-term changes in habitat quality. Such criteria then **must** be used by urban planners, developers, industrialists, and government agencies resonsible for coastal and shelf development. Likewise, generic findings from research and monitoring in one zoogeographic province can and must be applied to other regions.

Moreover, marine scientists interested in managing habitats should garner a greater knowledge about certain behavioral characteristics of the more important fishes. No nation in the world has a public health service which would knowingly wait until large numbers of individuals are demonstrably ill **before** making adjustments in the environment known to cause a particular illness. We should not wait until fish and shellfish become sick before taking action! Behavioral cues often can be used to show when fish are stressed. We should use certain behavioral standards, along with measurable ecological changes, to illustrate (warn) that fish are indeed under stress and subject to the effects of minimal or sublethal levels of pollution; we must not, in the future, wait until we have Raritan Bays and Boston Harbors before us to indicate that something is wrong.

Finally, personnel working within the general area of habitat quality, especially those doing research, should begin to tailor their research activities so that the resulting data can be used in "models" that are important to the management of marine fisheries. To date field and laboratory experiments have rarely been of a nature that would allow the data to be "plugged into" the general fishery assessment schemes and models. A

recent paper, based on work done on Chesapeake Bay, "Use of Historical Data Sets to Determine Causes of Variability in Long-term Trends in the Abundance of White Perch in the York and Choptank Rivers" (Boreman, et al, 1990), contains a number of salient paragraphs directed to this particular theme. That working group suggested that "...environmental variables should be biologically realistic, match the temporal and spatial scale of the stock measure, and have some adequate resolution to detect important changes." They went on to define those environmental and water quality variables appropriate for assessments of the white perch and other anadromous stocks.

Boreman, et al (1990) went on to note that the "...general types of data necessary are believed to be known, (but) environmental modelling of fish recruitment poses profound difficulties." They elaborated upon the different temporal and spatial scales on which typical assessment and environmental data analyses occur. Assessment information is generally broad based and the data are garnered at least two times a year, and sometimes more frequently. They also noted that fish recruitment usually occurs once per year for a given stock. The real issue is, however, that environmental data are often taken once per year, and perhaps only once in history. Experiments are often performed in a laboratory without concern for when reproduction, spawning, recruitment, and growth might occur. Thus our environmental data are not easily relatable to assessment data or parameters, or to the more important phases of the actual life histories of fish.

The Working Group on Chesapeake Bay white perch also was concerned that errors occur "...because we do not know exactly what environmental parameters affect recruitment to a given fish population." Again, there is "foggy" thinking here; the continued emphasis on the recruitment process does not really take into consideration how environmental variables might affect fish when they impress their effects at oögenesis, time of release of eggs, or early growth, and during subsequent metamorphosis and growth.

Boreman et al (1990) go on to suggest that "Despite the statistical and philosophical difficulties mentioned it does seem worthwhile to pursue environmentally influenced models of recruitment. Of course, one must be aware of the difficulties, but not allow them to cripple any inquiry." They further note that the foregoing problems only serve to emphasize the need for collection of consistent, long-term data sets, so that certain statistical considerations can be addressed. Obviously, environmental scientists concerned about habitat quality will have to make certain selections as to the data that should be collected. Once these decisions are made the data must be collected so that they can have reference to key life history points in a particular fish species; these may not be solely

those points having to do with the recruitment process! In many cases such inquiries and decisions can be made based on the literature that already exists. As I have emphasized, there are tens of thousands of papers having to do with aquatic habitat quality, the effects of contaminants and physical degradation on fish, and proposals for mitigation of or avoidance of effects from environmental contamination. It is worth reviewing the paper by Boreman et al. (1990) as well as others such as the one by Steele and Henderson (1984). The latter paper, concerned with modeling temporal fluctuations in fish stocks, is an important reference.

In conclusion I believe that we must:

- Start down a trail which involves close cooperation with other investigators, and which is based on a thorough review and assessment of the existing literature;
- recognize that there will have to be scores of disciplines involved in the development of environmental assessments, especially as they relate to fish stocks that must be managed under a FMP;
- use generic data and information to develop preliminary environmental assessments;
- begin to formulate habitat classifications, standards, and criteria and apply them in decision making, which commences with the development of case studies; and
- ensure that any procedures implemented must be straightforward and developed in a manner so that managers can understand the process being followed.

In regard to the last bullet, I would like to suggest that we follow the acronym **"SPIN"**. In this instance, the "S" stands for **simplicity**. The "P" stands for **palpable**; any activities that we carry out in the future must be able to be understood - palped, if you will - by people working at a range of levels from the general citizenry, through the environmental managers, and up to the research scientist carrying out the necessary measurements. The "I" stands for **individuals**. We cannot possibly deal with all species that might occupy a particular zoogeographic province (LME) or ecological niche. We must identify those key species which lend themselves to measurement in terms of how environmental well-being affects their biological processes which culminate in harvestable stocks. Finally, the "N" stands for **numerous**. Scientists developing the quantifiable

processes which will lead to measurements of appropriate variables must understand that their measurements of individual species should be transferable to managing large communities and populations of individual species, and species complexes. **Numerous** would suggest that there are great values in generic information which can be used or transferred from one situation to another.

Probably the first, and perhaps most important steps would have to do with developing appropriate criteria and standards for environments. Groups such as the American Fisheries Society (AFS) could dedicate themselves to no more important issue at the moment than developing a consensus on the importance of certain variables and establishing the standards that would be necessary to manage by. The actual management process would probably continue to be based upon models or calculations that are presently involved in developing fish assessments. In addition to typical fisheries stock information, however, the modelers and assessment scientists must build into their calculations the environmental variables which concensus suggests are "key" to fish stocks.

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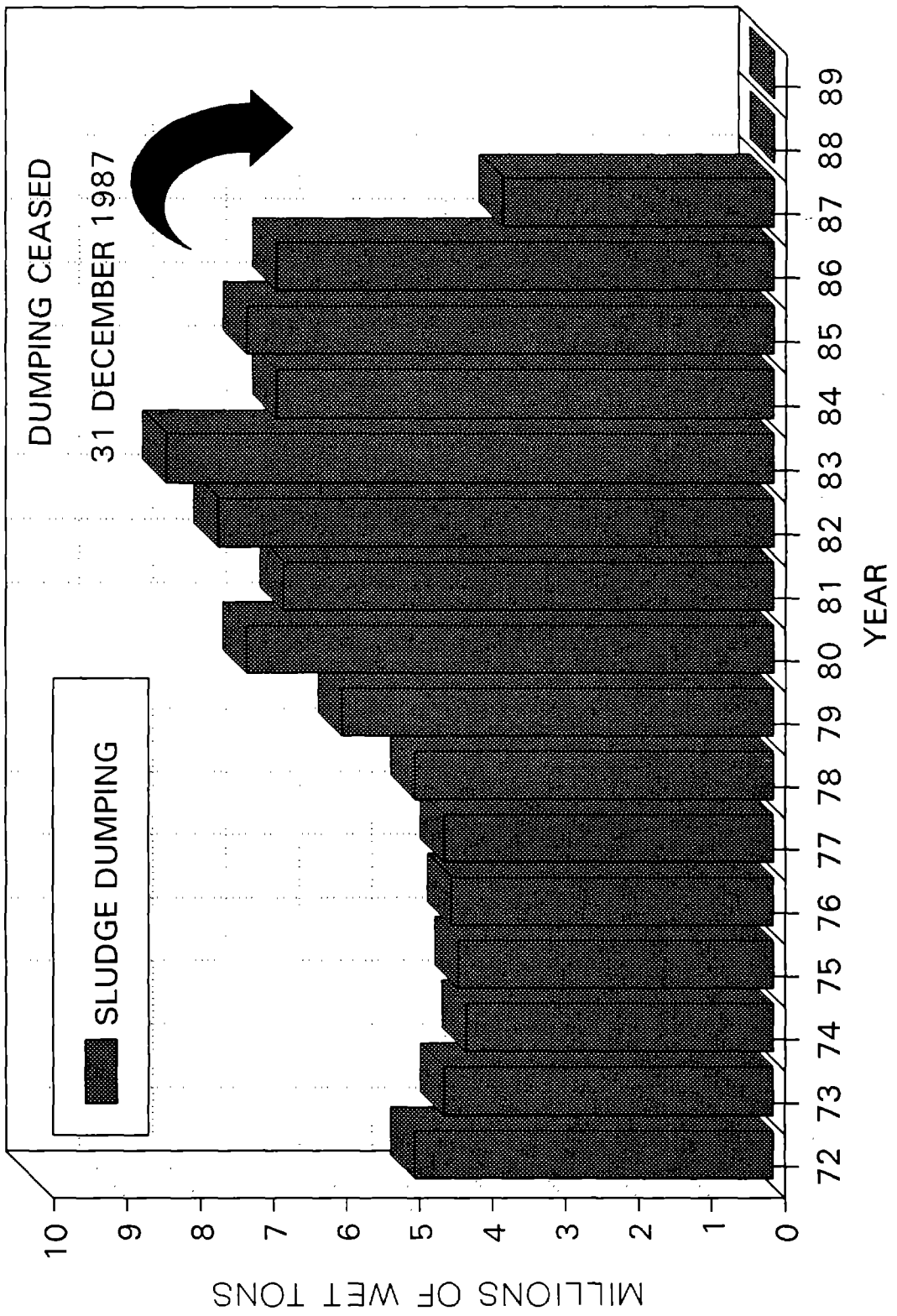
Appendix I
Overheads for Review of 12-Mile Dumpsite Recovery Study

12-MILE DUMP SITE RECOVERY STUDY

Response of the Habitat and Biota of the Inner New York Bight to Abatement of Sewage Sludge Dumping


DUMPING CEASED
31 DECEMBER 1987
SLUDGE DUMPING
MILLIONS OF WET TONS
0
1
2
3
4
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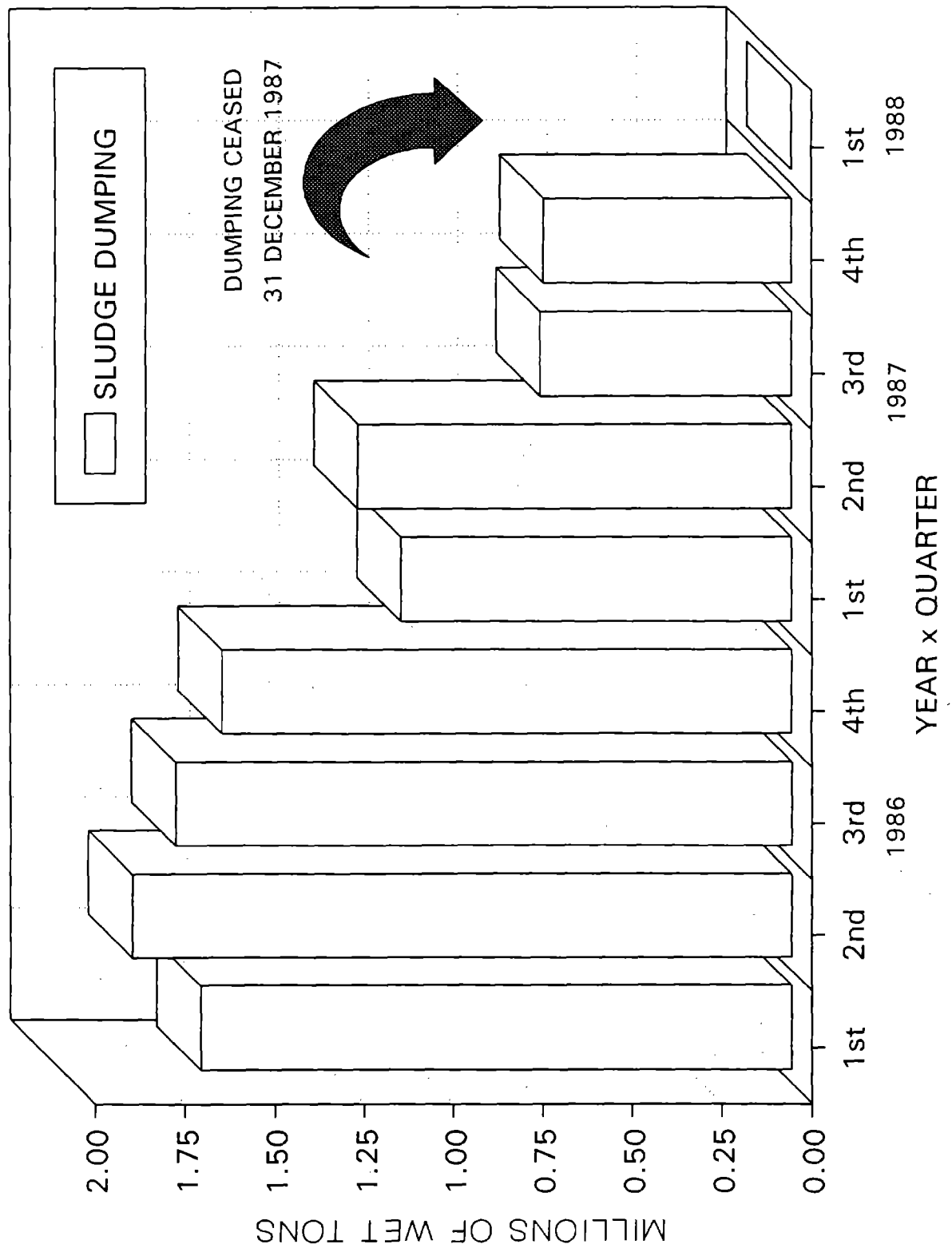
6
7
8
9
10
72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89
YEAR


SLUDGE DUMPING
DUMPING CEASED
31 DECEMBER 1987
MILLIONS OF WET TONS
2.00
1.75
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1.00
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0.50
0.25
0.00
1st
2nd
3rd
4th
1st
2nd
3rd
4th
1st
1986
1987
1988
YEAR x QUARTER

STUDY OBJECTIVES

DOCUMENT THE RESPONSE, EXTENT, AND RATE OF RECOVERY OF SEWAGE-POLLUTED HABITATS

ASSESS CHANGES IN DISTRIBUTION, ABUNDANCE, DIET, DISEASE, AND CONTAMINATION OF RESOURCE SPECIES

DETERMINE WHEN AREA CAN BE REOPENED FOR SHELLFISHING

DELINEATE SLUDGE CONTAMINATION FROM DREDGE AND RIVER

DETERMINE FATE OF SEWAGE POLLUTION IN C. BASIN AND HSV

MODEL RESPONSES TO POLLUTION LOADING AND ABATEMENT USEFUL IN PREDICTING RESPONSES IN OTHER PROPOSED SITES

EVALUATE DECISION TO DIVERT SEWAGE WASTES TO 106 SITE

STUDY PARTICIPANTS

Environmental Processes Division, NEC, NOAA
(Sandy Hook, Woods Hole, Narragansett)

US EPA , Environmental Research Laboratory, RI

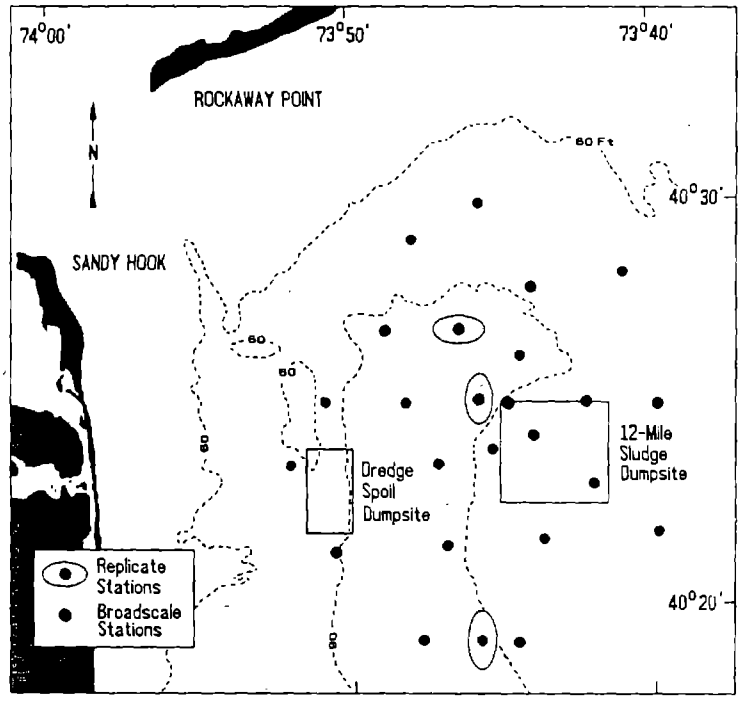
Lamont-Doherty Geological Observatory

NJ Dept. Environmental Protection

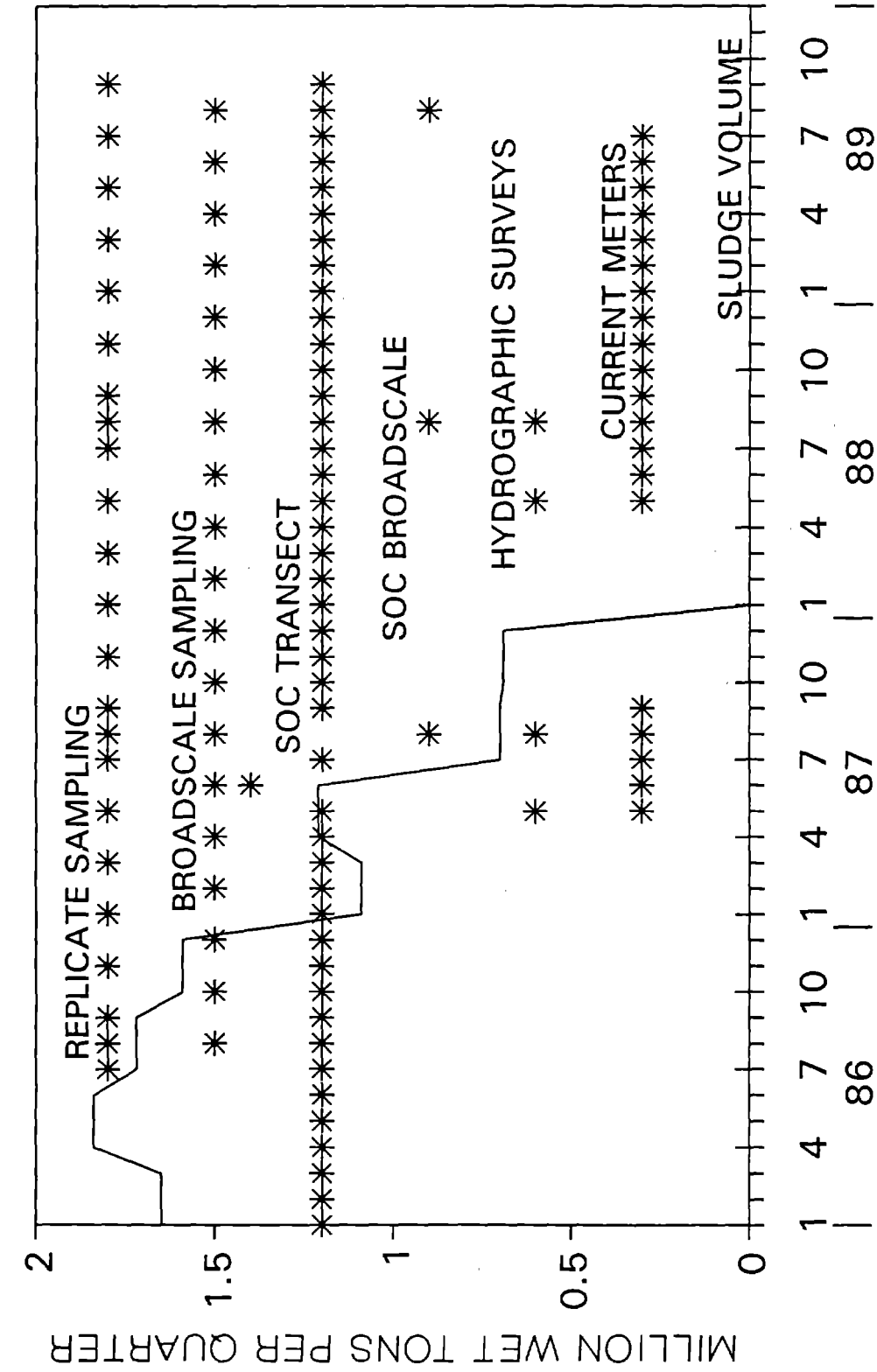
US FDA, Davisville, RI

Southeast Fisheries Center, Beaufort, NC

US EPA, Region II, Edison, NJ


74°00'
73°50'
73°40'
ROCKAWAY POINT
N
60 Ft
40°30'
SANDY HOOK
60
60
60
60
Dredge
Spoil
Dumpsite
12-Mile
Sludge
Dumpsite
Replicate
Stations
Broadscale
Stations
40°20'

12-MILE DUMP SITE RECOVERY STUDY
SURVEY SCHEDULE



HABITAT (WATER)

BOTTOM WATER

DISSOLVED OXYGEN
TEMPERATURE
SALINITY

pH
SULFIDE

NUTRIENTS
TURBIDITY

WATER COLUMN

DISSOLVED OXYGEN
TEMPERATURE
SALINITY

CURRENT MEASUREMENTS
(USING MOORED METERS)

HABITAT (SEDIMENTS)

CHEMISTRY

HEAVY METALS

ORGANIC CONTAMINANTS

SULFIDE, pH PROFILES

REDOX POTENTIAL

SEDIMENT BOD

CHLOROPHYLL PIGMENTS

TOTAL ORGANIC CARBON

CHARACTERISTICS

GRAIN SIZE

ERODIBILITY

OTHER

SEABED OXYGEN-CONSUMPTION-RATES

SEDIMENTATION-RATES

BACTERIA
- COLIFORM
- VIBRIO
- CLOSTRIDIUM
- TOTAL COUNT

BIOTA

RESOURCE SPECIES

DISTRIBUTION
ABUNDANCE
DIET
  WINTER FLOUNDER
  LOBSTER, RED HAKE
GROSS PATHOLOGY
  WINTER FLOUNDER
  LOBSTER
TISSUE ORGANICS
  WINTER FLOUNDER
  LOBSTER
MIGRATION
  WINTER FLOUNDER
  LOBSTER

BENTHIC MACROFAUNA

DISTRIBUTION
ABUNDANCE

BACTERIA

COLIFORMS IN SHELLFISH

ANTICIPATED CHANGES

(Hypotheses)

#2. Following cessation of dumping and demonstrated shifts in sediment contaminants and benthic forage species, abundance and distribution of finfish and megabenthic invertebrates at the most polluted sites will be similar to the relatively cleaner reference stations.

#3. The diet of winter flounder, lobster and other species will change following shifts in the availability of benthic prey at the replicate sites during the period in which dumping is phased out.

#9. Levels of organic contaminants in gut contents of winter flounder and lobster will decrease following cessation of dumping, but body burden levels will not shift since species are seasonal migrants.

ANTICIPATED CHANGES
(Hypotheses)

#10. Black gill disease, fin erosion, ulceration, incidence of parasitism, tumors and skeletal anomalies will significantly decrease in finfish and megabenthic invertebrates.

#8. Levels of bacteria indicative of recent sewage contamination in surf clams will decrease to acceptable levels which will permit shellfish beds to open

ANTICIPATED CHANGES
(Hypotheses)

#11. The intensity of perennial hypoxia (now to 0.46 mg O2/L) will be relieved -- minimum values 4 mg/L at 1 m above bottom, and 2 mg/L at 0.1 m -- throughout the Basin but not in isolated localities of dredge spoils.

#5. The number of crustacean forage organisms in the "enriched" and "highly altered" zones will increase significantly ...

#6. The numbers of benthic species in the "enriched" and "highly altered" zones will increase significantly.

ANTICIPATED CHANGES
(Hypotheses)

#21. The cleansing of sewage sludge from the Christiaensen Basin will be accomplished by episodic down-valley transport of sludge which can be related to windfield conditions.

#14. Trace metal concentrations in the sediment will decrease by about an order of magnitude in the depositional areas (except in dredge spoils).

#18. Seabed oxygen consumption rates in the Christiaensen Basin, may be reduced by approximately half, to around 12 - 22 ml O2 m2/hr, which is natural for accumulation areas if other anthropogenic inputs (i.e., dredge materials) remain constant.

SCALE OF "RECOVERY" OF "12 MILE-DUMP SITE"

1976 NY BIGHT ANOXIA

NJ COASTAL HYPOXIA

EMIGRATION OF FISH

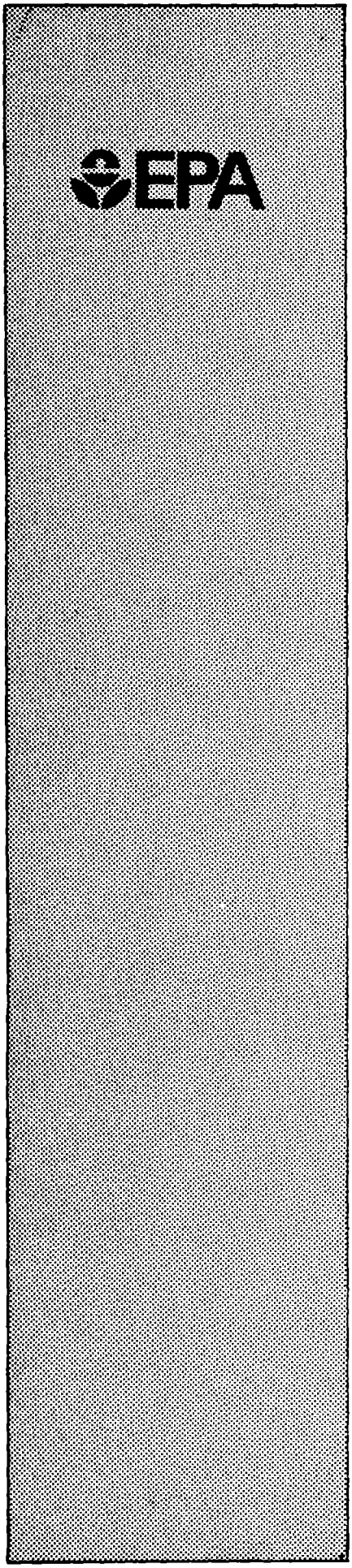
SHELLFISH CLOSURE

CHRISTIAENSEN BASIN

REPLICATE STATIONS

KM 2

Appendix J
Handout and Overheads for Review of the Environmental Monitoring and Assessment Program



United States
Environmental Protection
Agency

Office of Modeling,
Monitoring Systems and
Quality Assurance (RD-680)
Washington DC 20460

Research and Development

EPA/600/9-90/001 January 1990

Environmental Monitoring and Assessment Program

Overview

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Overview

This document presents an overview of the rationale, goals, and primary elements of the Environmental Monitoring and Assessment Program (EMAP), which represents a long-term commitment to assess and document periodically the condition of the Nation's ecological resources. EMAP is being designed by the U.S. Environmental Protection Agency's (EPA) Office of Research and Development. The program will serve a wide spectrum of users: decision-makers who require information to set environmental policy; program managers who must assign priorities to research and monitoring projects; scientists who desire a broader understanding of ecosystems; and managers and analysts who require an objective basis for evaluating the effectiveness of the Nation's environmental policies.

Monitoring, Regulatory, & Policy Needs

Environmental regulatory programs have been estimated to cost more than $70 billion annually, yet the means to assess their effect on the environment over the long term do not exist. While regulatory programs are based upon our best understanding of the environment at the time of their development, it is critical that long-term monitoring programs be in place to confirm the effectiveness of these programs in achieving their environmental goals and to corroborate the science upon which they are based.

The EPA, the U.S. Congress, and private environmental organizations have long recognized the need to improve our ability to document the condition of our environment. Congressional hearings in 1984 on the National Environmental Monitoring Improvement Act concluded that, despite considerable expenditures on monitoring, federal agencies could assess neither the status of ecological resources nor the overall progress toward legally-mandated goals of mitigating or preventing adverse ecological effects.. In the last decade, articles and editorials in professional journals of the environmental sciences have repeatedly called for the collection of more relevant and comparable ecological data and easy access to those data for the research community.

Affirming the existence of a major gap in our environmental data and recognizing the broad base of support for better environmental monitoring, the EPA Science Advisory Board (SAB) recommended in 1988 that EPA initiate a program that would monitor ecological status and trends, as well as develop innovative methods for anticipating emerging problems before they reach crisis proportions. EPA was encouraged to become more active in ecological monitoring because its regulatory responsibilities require quantitative, scientific assessments of the complex effects of pollutants on ecosystems. EMAP is being initiated in 1990 by EPA in response to these recommendations.

EMAP's Purpose

EMAP is being designed to monitor indicators of the condition of our Nation's ecological resources. Specifically, EMAP is intended to respond to the growing demand for information characterizing the condition of our environment and the type and location of changes in our environment. Simultaneous monitoring of pollutants and environmental changes will allow us to identify likely causes of adverse changes. When fully implemented, EMAP will answer the following questions:

- What is the current status, extent, and geographic distribution of our ecological resources (*e.g.*, estuaries, lakes, streams, wetlands, forests, grasslands, deserts)?
- What proportions of these resources are degrading or improving, where, and at what rate?
- What are the likely causes of adverse effects?
- Are adversely-affected ecosystems responding as expected to control and mitigation programs?

EMAP will provide the Administrator, the Congress, and the public with statistical data summaries and periodic interpretive reports on ecological status and trends. Because sound decision-making must consider the uncertainty associated with quantitative information, all EMAP status and trends estimates will include statistically-rigorous confidence limits.

Assessments of changes in our Nation's ecological resource conditions require data on large geographic scales collected over long periods of time. For national assessments, comparability of data among geographic regions (*e.g.*, the Northeast, Southeast, and West) and over extended periods is

critical, and meeting this need by simply aggregating data from many individual, local, and short-term networks that are fragmented in space or time has proven difficult, if not impossible. EMAP will focus specifically on national and regional scales over periods of years to decades, collecting data on indicators of ecological condition from multiple ecosystems and integrating them to assess environmental change. This approach, along with EMAP's statistically-based design, distinguishes it from most current monitoring efforts, which tend to be short-term or locally-focused. A long-term, integrated, multi-ecosystem monitoring program offers the advantages of earlier detection of problems and improved resolution of their extent and magnitude, while enabling formulation of more cost-effective regulatory or remedial actions.

Environmental monitoring data are collected by EPA to meet the requirements of a variety of regulatory programs. Many federal agencies collect environmental data specifically to manage particular ecological resources. Efficient execution of EPA's mandate to protect the Nation's ecosystems requires, therefore, that EMAP complement, supplement, and integrate data and expertise from the regulatory offices within EPA and from other agencies. EMAP should not be perceived as a substitute for ongoing programs designed to meet objectives other than its own. Interagency coördination is actively being pursued with the Departments of Interior, Commerce, and Agriculture. This coördination avoids duplicative monitoring efforts, facilitates exchange of existing data for use in the refinement of monitoring networks, and increases the expertise available to quantify and understand observed status and trends. EMAP will also draw upon the expertise and activities of the EPA Regional Offices, States, and the international community.

Ecological monitoring programs of the 1990's and beyond must be able to respond and adapt to new issues and perspectives within the context of a continuing effort to detect trends and patterns in environmental change. These demands will be met by EMAP through a flexible design that can accommodate as yet undefined questions and objectives as well as changing criteria of performance and scientific capability. Further, EMAP's design will encourage analysis, review, and reporting processes that foster discovery of unanticipated results and promote the widespread dissemination of scientifically-sound information. Periodic evaluations of the program's direction and emphasis will be the key to maintaining its viability and relevance while retaining the continuity of the basic data sets. These evaluations will serve to preclude the "aging" that typically hinders long-term monitoring efforts.

Planning & Design

The major activities in 1990 around which EMAP is being developed are:

- **Indicator Evaluation and Testing**—evaluation and testing of indicators of ecological condition;
- **Network Design**—design and evaluation of integrated, statistical monitoring networks and protocols for collecting status and trends data on indicators;
- **Landscape Characterization**—nationwide characterization of ecological resources in areas within the EMAP sampling network to establish a baseline for monitoring and assessment; and
- **Near-Coastal Demonstration Project**—implementation of regional-scale surveys to define the current status of our estuarine resources.

Although the goal is to establish the program in all categories of ecosystems, the initial emphasis is on testing and implementing the program in estuaries, near-coastal wetlands, and inland surface waters, coördinating these activities with the National Oceanic and Atmospheric Administration, the U.S. Fish and Wildlife Service, and the U.S. Geological Survey. Because precipitation and air quality are two important factors influencing ecosystems, EMAP also will contribute to the evaluation and maintenance of the multiagency atmospheric deposition networks currently coördinated by the National Acid Precipitation Assessment Program (*i.e.*, the National Trends Network/National Dry Deposition Network). These ecosystems and deposition networks offer immediate opportunities to demonstrate the EMAP approach.

EMAP also will contribute to the development of a research program in environmental statistics. This program will refine the statistical framework for the remaining types of ecosystems in preparation for full implementation of EMAP in 1995 and beyond. Relying heavily on expertise from academia and industry, this program will develop methods and approaches for: *(a)* analyzing and interpreting spatial and temporal trends in indicators across regions; *(b)* incorporating and substituting historical data and data from ongoing monitoring programs into EMAP; *(c)* designing efficient quality assurance programs for ecological monitoring programs; and *(d)* diagnosing the likely causes of adverse conditions in ecosystems.

Indicator Evaluation & Testing

Purpose

EMAP will evaluate and use indicators that collectively describe the overall condition of an ecosystem. Measurements of ecosystem condition should reflect characteristics clearly valued by society. Measurement methods must be standardized and quality-assured so that spatial patterns and temporal trends in condition within and among regions can be accurately assessed.

Strategy

Indicators in three categories will be evaluated:

- **Response indicators**—which quantify the response of ecosystems to anthropogenic stress. Examples include signs of gross pathology (*e.g.*, the appearance of tumors in fish or visible damage to tree canopies); the status of organisms that are particularly sensitive to pollutants or populations of organisms important to sportsmen, commercial interests, or naturalists; and indices of community structure and biodiversity.

- **Exposure indicators**—which show whether ecosystems have been exposed to pollutants, habitat degradation, or other causes of poor condition. Examples include ambient pollutant concentrations; acidic deposition rates; bioaccumulation of toxics in plant and animal tissues; media-specific field bioassays using test organisms; and measurements of habitat condition or availability (*e.g.*, siltation of bottom habitat and vegetative canopy complexity).

- **Stressor indicators**—which are socio-economic, demographic, and regulatory compliance measurements that are suggestive of environmental stress. Examples include coal production, population figures, pesticide applications, pollutant emissions inventories, and land use.

Sets of indicators will be identified and measured in all categories for each ecosystem type. The set of response indicators should reflect adverse effects of both anticipated and unanticipated environmental stresses (*e.g.*, new pollutants). Criteria must be developed for each response indicator to identify when conditions change from acceptable or desirable to unacceptable or undesirable. Criteria could be based on conditions attainable under best management practices as observed at "regional reference sites", relatively undisturbed sites that are typical of an ecoregion. A set of exposure indicators will be used to determine whether ecosystems have been exposed to environmental stress and what the causes of poor condition are likely to be. For example, undesirably low diversity in stream fish communities across a region might be related to the presence of toxics in sediments, siltation of bottom habitat, insufficient flow, low pH, or bioaccumulation of toxics. In this example, stressor indicators that might be examined in diagnosing the cause would include the number and type of industrial dischargers, farmed acreage or construction activity, water withdrawals, presence of mine spoils or acidic deposition, and regional pesticide application.

The goals of EMAP are quite different from those of the compliance monitoring most commonly conducted by EPA. While compliance monitoring involves identifying, with a high degree of confidence, pollutant concentrations that can be linked unequivocally to individual polluters, EMAP will use sets of indicators to assess the condition of multiple ecological systems across regions, coupled with an evaluation of associated pollutant sources or other anthropogenic environmental disturbance. EMAP's regional approach to environmental monitoring and assessment is quite unusual, and the expected benefits include an improved capability to detect emerging problems and to identify those types of ecosystems most in need of research, assessment, or remediation. Regional monitoring and assessment is the only effective way to determine whether current environmental regulations are adequately protecting our ecological resources.

Activities

Many scientific questions remain to be answered. Is the natural variability in response indicators too large to make sufficiently precise estimates of regional conditions? Can ecosystem condition be compared among regions with differing biota? What criteria will be used to determine acceptable versus unacceptable conditions? How are the data best interpreted for systems with response indicators in undesirable ranges and multiple, conflicting, or unknown exposure indicators? What, if anything, might be done when a system's range in response indicators is acceptable, but the range in exposure indicators is not? EMAP will seek short- and long-term answers to these questions through three types of activities:

- Reports evaluating the availability and applicability of indicators for all EMAP ecosystem categories;

- Workshops on ecological indicators; and

- Development of a long-term indicator research program for all EMAP ecosystem categories.

Network Design

Purpose

Meeting the goal of estimating status and trends in the condition of the Nation's ecosystems requires a monitoring framework that:

- Provides the basis for determining and reporting on ecological indicators at various geographic scales;

- Is adaptable to monitoring on regional as well as on continental and global scales;

- Enables the examination of correlations among spatial and temporal patterns of response, exposure, and stressor indicators;

- Enables the incorporation or substitution of data from ongoing monitoring sites and networks; and

- Is sufficiently adaptable and flexible to accommodate changes in spatial extent of the resource (*e.g.*, the areal extent of wetlands) and to address current and emerging issues.

Strategy

A global grid will be constructed for identifying sampling sites. This grid will then be divided into sub-grids in accordance with whatever scale of resolution (*e.g.*, national, regional, or subregional) is required for an assessment of the condition of ecological resources. Currently, a sub-grid for the United States and its surrounding continental shelf waters that includes approximately 12,500 sites is being evaluated. Within these sites, ecosystems will be identified and characterized and their their number and areal extent will be determined. This initial characterization will be accomplished using existing maps, satellite imagery, and aerial photography. Field sampling of sets of indicators will be conducted on a subset of sites statistically selected from the 12,500 original sites.

Current EMAP research will determine the number of sampling sites needed for regional and national reports on the status, changes, and trends in indicators. Two alternative approaches for field sampling of approximately 3,000 sites are being considered. In the first, about one-fourth of the 3,000 sites across the continental United States would be visited in one year. The following year, a second one-fourth of the sites would be sampled and so on, such that all sites would be visited during a four-year period. In the second, data would be collected during a single year at all the sampling sites in a geographical area (*e.g.*, the estuaries in the Virginian Province from Cape Cod to Cape Hatteras or all lakes and streams in the Northeast) and sampling efforts would shift to a new area during following years. The statistical, logistical, and reporting advantages of each option are being evaluated in light of EMAP's long-term goal to provide a national assessment of the status, changes, and trends in ecological resources. In addition, the timing of the sampling period, the statistical procedures for establishing where a measurement is to be made, and the number of samples that must be collected at each sampling site are being examined.

Activities

Current activities are focused on making the global grid final, applying it to the United States, and identifying rules for associating ecosystems with grid points and statistically selecting them for sampling. The EMAP design and sampling strategy will be reviewed by the American Statistical Association and appropriate ecosystem experts.

Landscape Characterization

Purpose

National assessments of status and trends of the condition of ecosystems require knowing not only what percentage of a particular resource is in desirable or acceptable condition, but also how much of that resource exists. Some types of wetlands are being lost at an alarming rate; conversion and loss of other types of ecosystems are also occurring. Such changes may be of particular concern if statistically correlated with pollutant exposure or other anthropogenic stressors. For most ecosystems, few national data bases can currently be used to derive quantitative estimates of ecosystem extent and changes in condition on a regional basis with known confidence.

The technique that will be used to address these issues is landscape characterization. Landscape characterization is the documentation of the principal components of landscape structure—the physical environment, biological composition, and human activity patterns—in a geographic area. EMAP will characterize the national landscape by mapping landscape features (*e.g.*, wetlands, forests, soils, and land uses) in areas associated with the EMAP sampling grid. Characterization uses remote sensing technology (satellite imagery and aerial photography) and other techniques (*e.g.*, cartographic analysis and analysis of census data) to quantify the extent and distribution of ecosystems. Over time, periodic aerial and satellite photography will permit quantitative estimation of changes in landscape features that might be related to anthropogenic activities and pollutants. The results of these characterization analyses also permit more informed selection of systems for field sampling.

Strategy

The characterization strategy involves the application of remote sensing technology to obtain high-resolution data on selected sample sites and lower resolution data over broad geographical areas. Other data sources such as maps and censuses will be used to supplement the remote sensing data.

The remote sensing data also will furnish detailed information needed for the network design. For example, lakes, streams, wetlands, forests, and other types of ecosystems associated with each grid point will be identified so that a subset for field sampling can be statistically selected. Characterization also supplies a portion of the data needed to classify ecosystems into subcategories of interest (*e.g.*, forest-cover types, wetland types, crops, and lake types).

Certain types of landscape data assist in diagnosing the probable causes of undesirable conditions in response indicators. Characterization will describe the physical and spatial aspects of the environment that reflect habitat modification, for example, those that can amplify or counteract the effects of toxicants and other pollutants on plants and animals.

Finally, characterization will compile data on stressor indicators that can be identified from remote sensing and mapped data, including land use, mining activities, population centers, transportation and power corridors, and other anthropogenic disturbances.

EMAP will assemble, manage, and update these data in Geographic Information System (GIS) format. A standardized characterization approach and a landscape information network common to all ecosystems will be used to optimize cost and data sharing and to ensure common format and consistency. Through close work with other agencies, EMAP will

establish design requirements for the integrated characterization including acceptance criteria for baseline data, consistent classification detail and accuracy, and suitable spatial and temporal resolution to distinguish landscape features of particular interest.

Activities

The design of the characterization plan and the evaluation of potential characterization techniques are in progress. A prototype methodology for high-resolution characterization has been developed. Current activities include evaluating a range of methods, from landscape ecology to quantitative, multistage remote sensing (combined satellite and aerial photography) in widely different terrain types. EMAP characterization will begin in 1990 at approximately 800 sites, or about one-fourth of the 3,000 selected for field sampling.

Near-Coastal Demonstration Project

Purpose

Information obtained from the near-coastal demonstration project will be used to refine the EMAP design, and the study itself will serve as a model for implementing EMAP projects in other study areas and types of ecosystems.

The demonstration project has five goals:

- Evaluate the utility, sensitivity, and applicability of the EMAP near-coastal indicators on a regional scale;
- Determine the effectiveness of the EMAP network design for quantifying the extent and magnitude of pollution problems in the near-coastal environment;
- Demonstrate the usefulness of results for planning, priority-setting, and determining the effectiveness of pollution control actions;
- Develop standardized methods for indicator measurements that can be transferred to other study areas and made available for other monitoring efforts; and
- Identify and resolve logistical issues associated with implementing the network design.

Strategy

The strategy for accomplishing the above tasks is to work closely with the National Oceanic and Atmospheric Administration's National Status and Trends Program to field-test the near-coastal indicators and network design through a demonstration study in the estuaries and coastal wetlands of the Mid-Atlantic area of the United States. Estuaries were selected because their natural circulation patterns concentrate and retain pollutants. Estuaries and coastal wetlands are also spawning and nursery grounds for many valued living resources, and estuarine watersheds receive a large proportion of the pollutants discharged to the Nation's waterways. The Mid-Atlantic study area was chosen because adverse pollutant impacts are evident; contaminants are present in the water, sediments, and biota; the vitality of many organisms is reportedly threatened; and seven of the area's larger estuaries are included in EPA's National Estuary Program.

Activities

During 1989, the major environmental problems associated with near-coastal systems were identified: eutrophication, contamination, habitat modification, and the cumulative impact of multiple stressors. A set of response, exposure, and stressor indicators applicable to each problem is to be identified, based on current understanding of how various environmental stressors affect ecosystem processes and biota. Near-coastal ecosystems have been classified for monitoring and assessment based on their physical and chemical characteristics and their susceptibility to environmental stressors. A monitoring network design that is compatible with the EMAP design is being developed. Several logistical and technical questions regarding the EMAP near-coastal project remain, including:

- What set of indicators will be measured?
- What specific methods will be used to sample each indicator?
- Will all indicators be measured at all sampling sites or can a sampling plan be developed that requires measurement of costly indicators only at selected sites? and
- To what degree should sources of variation be measured and accounted for in the network design?

The near-coastal demonstration project will be conducted in the estuaries and coastal wetlands of the mid-Atlantic area of the United States (from Cape Hatteras to Cape Cod) during mid-1990. A report on the results of the project will be prepared in 1991.

Information Contact

EMAP is planned and managed by ORD's Office of Modeling, Monitoring Systems, and Quality Assurance (OMMSQA). Inquiries may be directed to:

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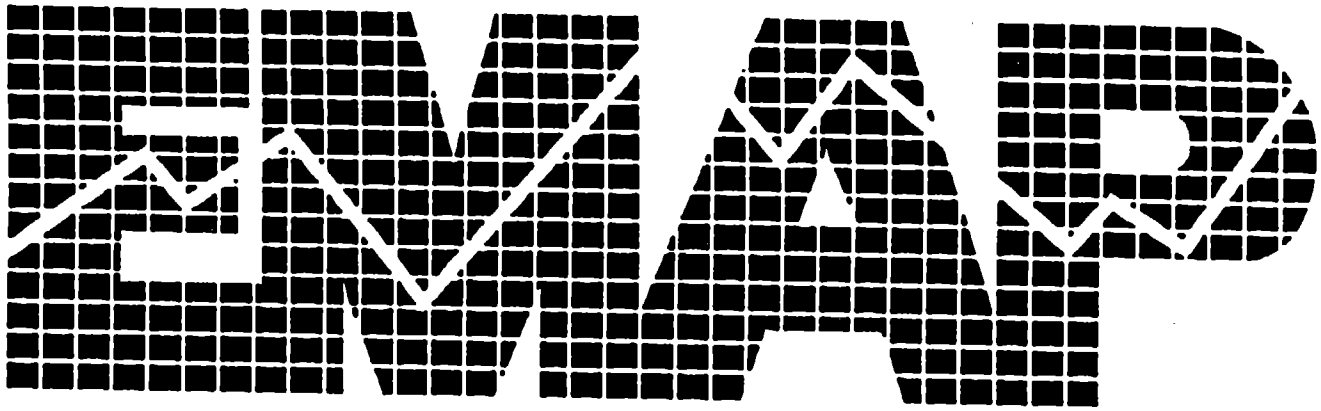
Fax: (202) 252-0929


UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY



An Approach to Ecological Monitoring and Research

EPA

EPA SCIENCE ADVISORY BOARD RECOMMENDATIONS

- Establish and Conduct an Ecological Research Program
- Initiate Monitoring Activities that Assess Ecological Status and Trends
- Develop Ecological Indicators that Form a Basis for Ecological Criteria and Standards
- Provide a National Focal Point for Ecological Research

EMAP

EPA

WHAT IS EMAP?

- **Environmental Monitoring and Assessment Program**

- **Includes Multiple Ecosystems:**
  - -- Agro-ecosystems
  - -- Forests
  - -- Inland Waters (streams, rivers, lakes)
  - -- Drylands/range lands
  - -- Wetlands (inland and coastal)
  - -- Near Coastal (estuaries, coastal waters)
  - -- Great Lakes

- **Characteristics to be monitored**
  - -- Ecological condition/status
  - -- Trends/change in status
  - -- Factors that affect ecological status

- **Scale of assessments**
  - -- Regional/national
  - -- Long-term

- **Involved federal program**
  - -- EPA
  - -- NOAA
  - -- USGS
  - -- FWS
  - -- USDA
  - -- NSF
  - -- DOE
  - -- NASA

EMAP

WHY IS EMAP NEEDED?

EPA cannot answer critical questions about the status of the environment

- **What is the extent and magnitude of pollution impacts on the Nation's ecosystems?**

  -- Acres
  -- %
  -- Degree of impact

- **Are things getting better or worse? Where? At what rate?**

- **What are the factors associated with degrading or improving conditions?**

- **Are regulatory programs and policies effective?**

EPA

EMAP'S MISSION

- Define Existing Conditions (Baseline or Status)
- Determine if Environmental Quality is Getting Better or Worse (Trends)
- Provide a Base for Comparative Risk Assessment (Associations)
- Develop Better Performance Measures (Indicators)
- Develop Technologies for Assessing Status and Trends (Methods)

EMAP

SCOPE OF EMAP-NC

- Estuarine and coastal wetlands
- Estuaries
- Coastal waters
- Great Lakes

IMPLEMENTATION STRATEGY

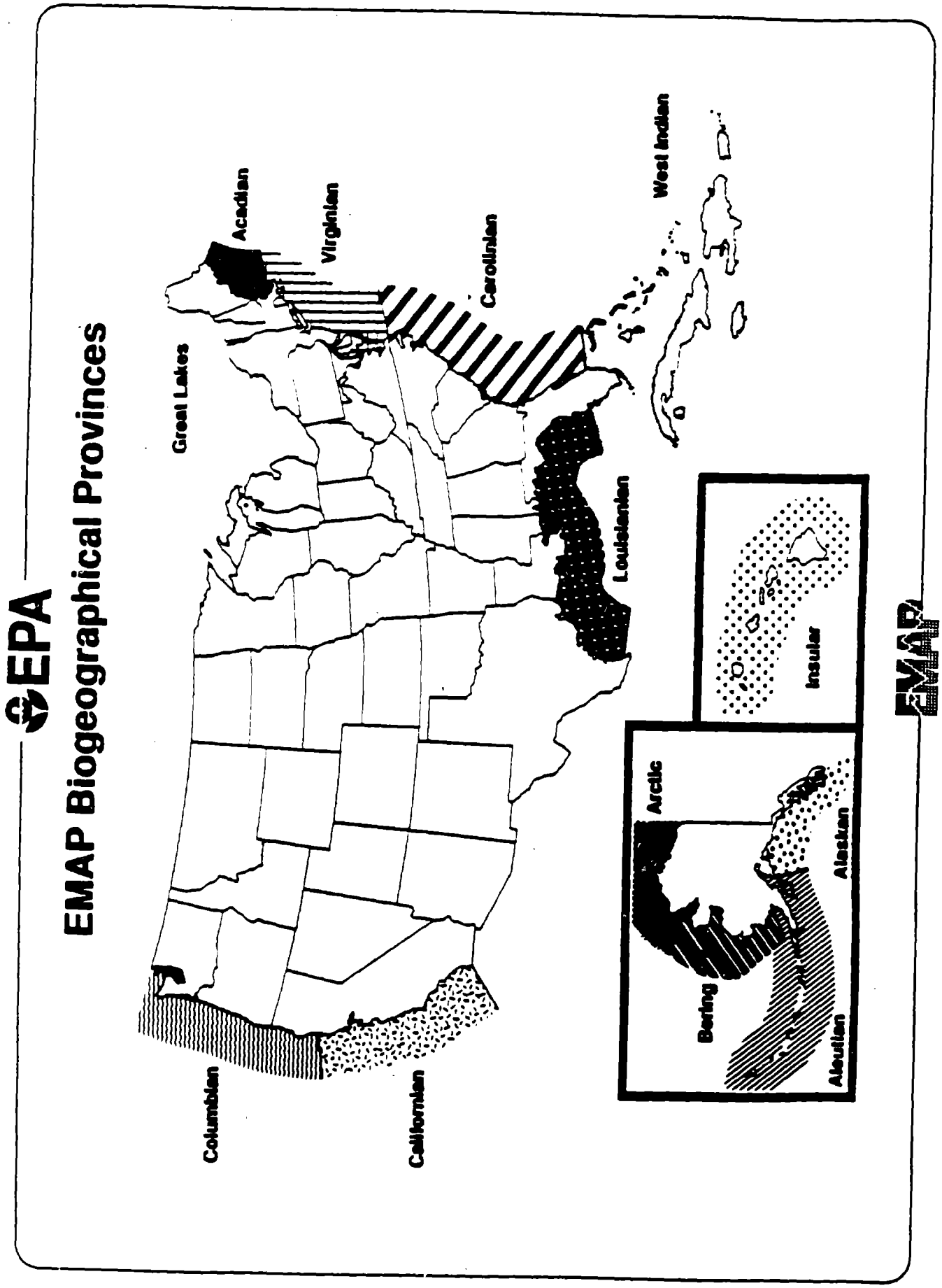
- Phased approach
- Estuaries first
- Wetlands and Great Lakes
- Coastal waters

MAJOR ENVIRONMENTAL PROBLEMS ADDRESSED

- Low dissolved oxygen concentration
- Contamination
- Habitat modification
- Cumulative impact
- Emerging environmental problems

SAMPLING DESIGN

- **Consistent with overall EMAP design**
- **Four major elements**
  - -- Index period
  - -- Regionalization
  - -- Classification
  - -- Statistical design
- **Index Period -- A time when indicators are expected to show the greatest response to pollution**
- **Regionalization -- subdivision into regions having similar ecological properties and constituting reasonable reporting units**
- **Classification -- organization into resource types to facilitate sampling and interpretation**
- **Statistical Design -- the specific approach used for selecting sampling locations**


EPA
EMAP Biogeographical Provinces
Great Lakes
Acadian
Virginian
Carolinian
West Indian
Louisianian
Columbian
Californian
Arctic
Bering
Aleutian
Aleutian
Insular
EMAP

INDICATOR SELECTION STRATEGY

- Define issues and endpoints of concern
- Develop conceptual model
- Identify candidate indicators using the model
- Screen and classify indicators according to evaluation criteria
- Conduct indicator testing and evaluation to define core indicators
- Re-evaluate all of the above periodically

RESPONSE INDICATORS

- **Benthic species composition, biomass, and abundance (C)**
- **Relative abundance of large burrowing bivalves (D/R)**
- **Fish species composition, size, and abundance (D/R)**
- **Fish gross pathology/histopathology (D/R)**
- **Contaminant concentrations in target fish/shellfish (D)**
- **Aesthetic indicators (D)**
  - -- Flotsam
  - -- Jetsam
  - -- Odor
  - -- Water clarity

EXPOSURE INDICATORS

- Sediment toxicity (D)
- Water column toxicity (R)
- Sediment contaminants (C)
- Dissolved oxygen concentration (D)
- Redox potential discontinuity (R)

HABITAT INDICATORS

- Salinity (C)
- Temperature (C)
- pH (R)
- Sediment characteristics (C)
- Water depth (C)

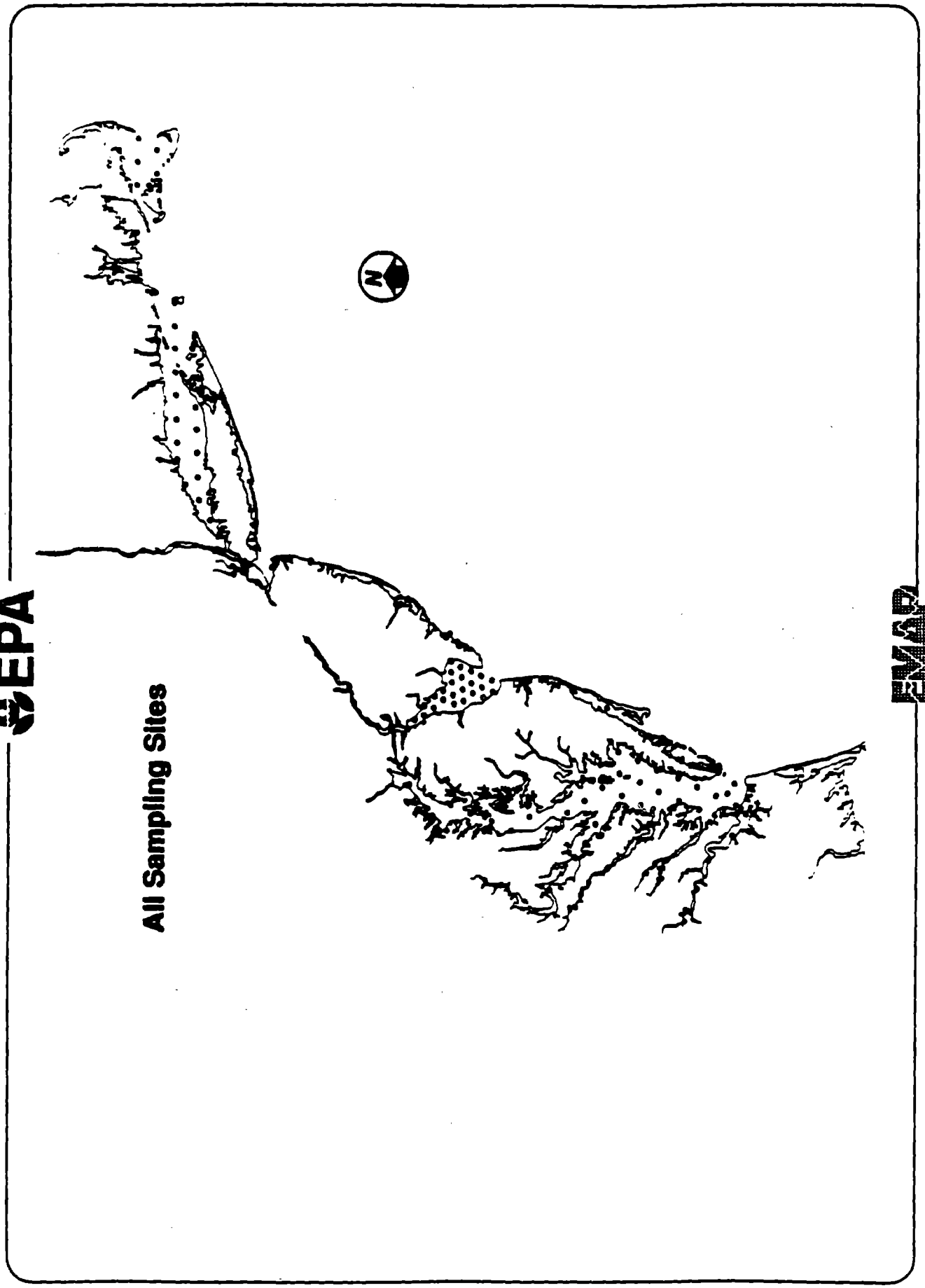
STRESSOR INDICATORS

- Fresh water discharge
- Climatic data
- Pollutant loadings by major category
- Watershed land use patterns by major category
- Human population density/ demographics
- Fishery landings statistics

GOALS OF FY 1990 DEMONSTRATION PROJECT

- Test and evaluate indicators
- Identify and resolve logistical problems
- Standardize sampling and processing methods
- Evaluate alternative sampling designs and refine study design
- Develop analysis procedures
- Demonstrate the value of the EMAP assessment approach

SAMPLING RESULTS			
	EXPECTED	ACTUAL	PERCENT REALIZED
Benthos	846	780	92% (98%)
Bivalve tows	138	102	74%
Fish trawls	477	346	73% (78%)
Fish Pathology	---	209	---
Fish Contaminants	---	1,538	---
Sediment Toxicity	165	162	98%
Water Column Toxicity	23	23	100%
Sediment Contaminants	165	162	98%
Continuous dissolved Oxygen	137	107	78% (82-90%)
Water Quality	571	474	83% (94%)
Sediment Characteristics	165	163	99%


EPA
All Sampling Sites
N
EMAP

FY91 ACTIVITIES

- **Continued sampling in Virginian Province**
- **Detailed analysis of Virginian Province data**
- **Demonstration project in Gulf of Mexico**
- **Evaluate developing joint activities with a state/local program**
  - -- Chesapeake Bay Program (integration effort)
  - -- Delaware Inland Bays (index development)
- **Work with NOAA on developing/ obtaining indicator data**
  - -- Stressor/climate data
  - -- Characterization data
- **Joint Assessment Report with NOAA**

Appendix K
Intergovernmental Agreement for Initiating, and Executive Summary of Document for Planning the Activities of, the Gulf of Maine Council on the Marine Environment

AGREEMENT ON

CONSERVATION OF THE MARINE ENVIRONMENT

OF THE GULF OF MAINE

BETWEEN

THE GOVERNMENTS OF THE BORDERING STATES AND PROVINCES

The Governments of Maine, Massachusetts, New Brunswick, New Hampshire, Nova Scotia, as Parties to this Agreement and;

Considering that the shoreline, seabed, waters and associated natural resources of the Gulf of Maine region, including Georges Bank and the Bay of Fundy, constitute precious public natural resources shared by the contiguous States and Provinces and;

Considering that the natural resources of the Gulf of Maine are interconnected and form part of an overall ecosystem that transcends political boundaries and;

Considering that the sustainable development and use of these resources for recreational and aesthetic enjoyment activities as well as fish and wildlife habitat is dependent on the ecological integrity of the Gulf ecosystem and;

Considering that the planning and management of human activities which may affect the Gulf ecosystem should recognize and be based upon an understanding of the systems' integrity and;

Considering that the Parties to this agreement recognize a shared duty to protect and conserve the renewable and non-renewable resources of the Gulf for the use, benefit and enjoyment of all their citizens, including generations yet to come and;

Considering that the most effective means of protecting, conserving and managing the region's resources is through the cooperative pursuit of consistent policies, initiatives and programs and;

Considering that studies conducted by National, State and Provincial governments and other agencies have found that, without prudent management, the future development and use of the Gulf resources may have significant adverse impacts on the environment, economy, and general welfare of the Parties and have agreed to the following:

1. The Parties agree to establish a Gulf of Maine Council on the Marine Environment to discuss and act upon environmental issues of common concern including but not limited to:

   -- the protection and conservation of the ecological balance within the Gulf of Maine ecosystem;

   -- the problem of marine debris and medical waste;

   -- the relationship between land use and the marine environment;

   -- the sustainable use of resources within the Gulf of Maine;

   -- cooperative programs to better protect and conserve the Gulf's natural resources.

2. The Gulf of Maine Council on the Marine Environment will be composed of two representatives from each of the Gulf of Maine States and Provinces to be appointed by their respective Governors and Premiers within 60 days of the effective date of this Agreement.

3. The Gulf of Maine Council on the Marine Environment will produce its first annual report on environmental trends and conditions including specific recommendations on a Gulf of Maine Action Plan within 15 months of its appointment.

4. The Parties agree to minimize actions that would result in degradation of environmental quality or depletion of resources that individually or cumulatively could result in significant adverse impacts on resources leading to loss of sustainable use or environmental viability.

5. The Parties agree to design and develop a coordinated monitoring program to provide improved information for future decisions concerning the Gulf.

6. The Parties agree that the successful conservation of Gulf resources will require the development of additional agreements or protocols on specific issues or concerns that may be raised from time to time.

SIGNATURES:

Honorable John R. McKernan, Jr.
Governor, Maine

Honourable John M. Buchanan
Premier, Nova Scotia

Honorable Judd Gregg
Governor, New Hampshire

Honourable Frank McKenna
Premier, New Brunswick

Honorable Michael S. Dukakis
Governor, Massachusetts

the Gulf of Maine

Maine
Nova Scotia
Massachusetts
New Brunswick
New Hampshire

Sustaining Our Common Heritage

COMPILED BY:
Katrina Van Dusen and Anne C. Johnson Hayden
Maine State Planning Office
November 1989

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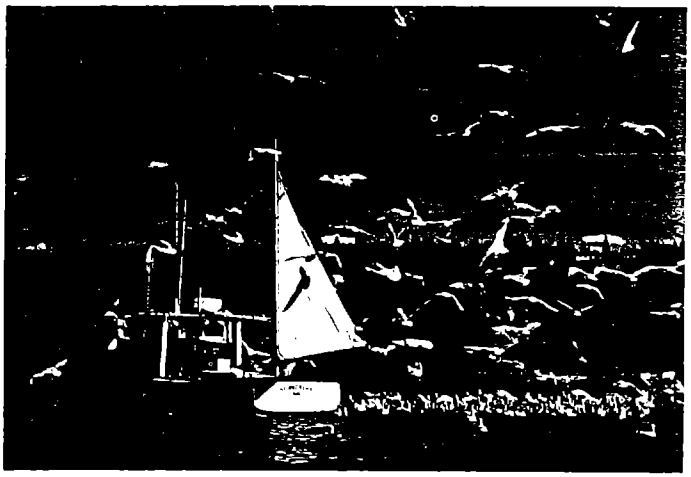
Executive Summary



Peter Ralston/Island Institute

RECOGNIZING THAT THE Gulf of Maine is a common resource of inestimable value to their residents, the Provinces of Nova Scotia and New Brunswick, the States of Maine and New Hampshire, and the Commonwealth of Massachusetts have joined in a cooperative effort to protect its ecological integrity and the many uses that depend upon its continued good health.

The Gulf is a marine ecosystem defined by currents and tides, nutrient cycles, and the migration of marine animals; it pays no heed to political boundaries separating states, provinces, or nations. The living marine resources of the ecosystem may spend part of their lives in coastal waters and part in offshore waters, part in Canadian waters and part in the waters of the United States; many species of fish, marine mammals, and birds lead transboundary lives. It is important to remember that environmental damage in one part of the Gulf can be felt in another and that a series of seemingly negligible effects can be of major harmful consequence in sum.

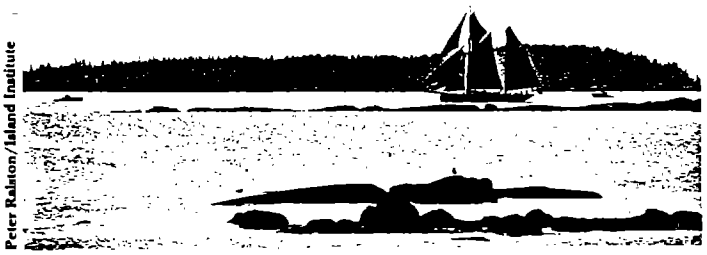
This report was compiled to illustrate that the Gulf supports diverse, and sometimes conflicting, uses; that it is an ecosystem that is best managed using ecological principles which do not "see" political boundaries; that the sustained use of the Gulf's resources, not only by present but by future generations, will depend upon wise stewardship of the Gulf environment; that cooperative effort on the part of the bordering States and Provinces will be required to protect the Gulf; and that prevention of degradation is less costly, more efficient, and more effective than remedial programs.

The Gulf of Maine is of great worth not only to the people of the Gulf region who depend upon it for economic, aesthetic, and recreational value, but also to the many others from outside the region who enjoy or profit from its resources. Among the most productive bodies of water on earth, the Gulf has nourished a thriving maritime heritage for several centuries.

The growth of the human population and consequent development in the Gulf region have resulted in a series of insults to the Gulf environment. Tons of raw and partially treated sewage are discharged into the Gulf each day. Industrial discharges and urban and agricultural runoff all introduce toxic contaminants and bacteria to marine and estuarine waters on a chronic, and at times acute, basis. Increased fishing effort has reduced fish stocks to all time lows. Coastal development has encroached on environmentally significant marine wetlands. Accidental spills of oil and other toxic material place additional stresses upon the Gulf environment.

Evidence of these stresses can be found throughout the Gulf. Although limited data exist to assess adequately the environmental quality trends in the Gulf of Maine, the warning signs of degradation are clear in research conducted during the last decade:

— highly industrialized harbors such as Boston and Saint John are seriously degraded; it is unlikely that such places will ever regain all of their natural functions;
— relatively undeveloped embayments, such as Penobscot Bay, exhibit elevated levels of contaminants in sediments;
— sediments in the deep basins of the offshore Gulf of Maine contain low but unnatural concentrations of toxins, indicating that contaminants are being transported throughout the Gulf.



While the effects of such stresses are not fully documented, natural processes in the Gulf are clearly being affected:

— certain fish and shellfish exhibit liver lesions, fin rot, and other signs of environmental stress;
— the right whale, piping plover, and other species of wildlife are endangered or declining;
— populations of some commercially valuable fish species depend upon an increasingly limited number of year classes, and some may not be reproducing themselves at all;
— health advisories have been issued in several nearshore regions of the Gulf to protect the public from the hazards associated with swimming in contaminated waters and eating contaminated seafood.

Impacts in the Gulf are not just ecological; coastal economies are affected by environmental degradation in the Gulf:

— the Gulf's fishing economy is in precarious condition because of declining fish stocks;
— several hundred thousands of acres of productive shellfish habitat are closed to harvesting due to sewage contamination, resulting in serious loss of livelihood;
— the public's increasing concern regarding contaminated seafood may be driving down the price of fish and shellfish;
— loss of traditional harvesting jobs has affected the character and economies of coastal communities whose fundamental heritage is maritime.

Of greatest importance for the future is the knowledge that the Gulf of Maine can be protected. While warning signs of environmental deterioration are evident, much of the Gulf remains healthy. Preventive action, however, will be required to maintain the environmental quality of the Gulf, as well as to reverse all trends toward degradation noted in this report. Now is the time to explore opportunities to ensure the continued viability of the Gulf and its many uses.

The Gulf of Maine must be managed as an ecosystem rather than as a series of political jurisdictions. A cooperative environmental strategy is required to direct a Gulf-wide monitoring effort, to provide for pollution abatement and control, and to promote the sustainable use of living resources.

A broad-based understanding of the ecological and economic values of the Gulf is essential for the improved stewardship of the Gulf. A public education effort, including public participation programs, curriculum supplements, films, and educational literature, will impart a greater sense of environmental responsibility among the public and generate support for environmental planning.

Effective management of the Gulf will require ongoing cooperative research on the structure and function of the Gulf ecosystem, as well as on the effects of pollution, habitat loss, and other stresses.

This report is a first step in a multilateral endeavor to improve environmental management of the Gulf. While provincial, state, and federal governments are taking this first step, the assistance of industries, municipalities, conservation groups, and individual citizens will be required if this initiative is to be successful. An unparalleled opportunity still exists to preserve and enhance the Gulf of Maine and its many uses: now is the time to work together to protect this invaluable resource.

Appendix L
Draft Cooperative Strategy for Quantifying Resource Losses Due to Habitat Loss or Degradation

March 12, 1991

NER Environmental Workshop

COOPERATIVE STRATEGY TO QUANTIFY LOSSES

For decades, scientists, resource managers, and regulators have been stymied by the lack of technical information linking habitat change and resource populations. These information gaps are most glaring in assessing the potential impacts of habitat degradation on protected or managed species. Although intuition suggests a connection, the nexus has not been proven to decision makers. A principal goal of this first Environmental Workshop is to develop a **cooperative strategy** to meet those needs. This paper offers a strategy and suggests specific products.

History confirms that no state or federal agency can solve this complex problem unilaterally. Similarly, one meeting and one product will not be sufficient, although research and products could be designed to apply to recurring issues. To affirm our commitment, we should agree to:

- clarify the advisory, management, scientific, and regulatory roles of each participating agency
- continue interagency coordination via meetings and regular communications
- recognize the limitations and data imperfections that will complicate our efforts
- determine appropriate roles for each agency
- agree on products such as data syntheses, loss assessments that will meet each agency's needs
- convince our agencies that this issue demands long-term support

To begin implementation, we should designate a subgroup of workshop attendees (or their representatives) to:

- develop a list of needs (data, syntheses documents, comparisons of habitat and stock trends, etc.)
- agree on a scientific protocol to quantify habitat losses and to relate those losses to populations of protected and managed species
- consider the need for an overall coordinator, perhaps on a rotating basis
- establish a communications system (electronic mail, regular mailings, etc.)

Your participation in this exercise is vital. Your scientific skills, management insights, regulatory powers, and conservation ethic will all prove valuable as we implement this cooperative strategy.