STATE OF MAINE
113TH LEGISLATURE
SECOND REGULAR SESSION

FINAL REPORT OF THE COMMISSION ON MARINE RESEARCH

DECEMBER 1988

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MARINE RESEARCH COMMISSION

I. EXECUTIVE SUMMARY

A. Findings

The Marine Research Commission finds that:

1. The Gulf of Maine is a resource of tremendous importance to the State both ecologically and economically.

2. Resources in the Gulf of Maine are experiencing problems from both human-induced and natural changes.

3. We do not know enough about basic physical and biological systems in the nearshore waters and the Gulf of Maine to know how much stress they can tolerate, what effects further human alterations will have and what actions would best restore and protect them.

4. A variety of programs and institutions conduct marine research within the state funded primarily by the federal government. However, there are limited means to support coordinated research addressing problems of importance specifically to Maine. In addition, recent trends have shown a decline in marine research funding from federal sources.

5. Marine research institutions in the state have basic facility constraints that must be addressed to enable them to continue to carry out high caliber marine research in the Gulf of Maine.

6. The University of Maine System has a shockingly inadequate marine research program considering the importance of the coast and ocean to Maine. A special Task Force on Marine Activities within the University of Maine has urged the University to strengthen its activities and organization in the marine field. The changes and actions they suggest are much-needed to increase the effectiveness of the University in marine activities.

7. The Bureau of Marine Science within the Department of Marine Resources is partially supported by federal funds. Recent trends have shown a decline in federal funds: three federally funded positions were recently lost and 10 more positions within the Bureau remain vulnerable to further reductions in those funds. This dependence undermines the long-term consistency and stability needed for an effective research program.

8. The Bigelow Laboratory of Ocean Sciences is the largest private marine research organization in Maine, providing unique research capabilities important to Maine and attracting significant out-of-state funds and world-wide prestige to Maine. Yet lack of funds for basic institutional support and its dependence on temporary grant funding jeopardizes the future of its contribution to solving Maine's marine resource problems.

9. Basic and applied research are important to managing and understanding the dynamics of the Gulf of Maine, as well as managing the impacts of growth and pollution on the quality of Maine's marine environment. Mapping and monitoring programs undertaken by state agencies and private organizations provide vital information for these research efforts. Yet these programs are skimpy and poorly funded.

B. Recommendations

In response to these findings, the Commission has proposed legislation for introduction into the one hundred and fourteenth Legislature that will:

1. Create a Marine Research Board within the Maine Science and Technology Commission to identify high priority research needs within the state. The Board will develop and administer a grants program to fund projects designed to meet those needs.

2. Fund current federally funded positions within the Department of Marine Resource's Bureau of Marine Science from the General Fund to alleviate DMR's dependence on federal funds and stabilize these positions.

3. Fully fund the librarian and assistant librarian positions at DMR's McKown Point library. Half of each position is now paid for by Bigelow Laboratories for the Ocean Sciences. Full state funding would allow Bigelow's portion of this funding to be put toward the Laboratory's other critical needs.

C. Additional recommendations

In addition, the Marine Research Commission supports:

1. The current appropriation to Bigelow Laboratory and recommends that this appropriation be continued or expanded. The Commission also supports consideration of appropriations to other private organizations, for example the Mount Desert Island Biological Laboratory whose marine research missions are of importance to the state.

2. The University of Maine's Task Force on Marine Activities report to President Dale Lick. This report makes solid recommendations to upgrade the University's role and effectiveness in the field of marine research and that effort should be supported. Specifically, the Commission supports the recommendation stressing the importance of a state match for the Sea Grant College Program.

3. Marine mapping and monitoring programs undertaken by state and private organizations. While the bill proposed by the Commission is focused on basic and applied research, continued monitoring and mapping efforts within the Gulf are essential to understanding our marine environment and the Commission strongly recommends increasing state support for this activity.

II. INTRODUCTION

1. The Commission on Marine Research

In the second session of the one hundred and thirteenth Legislature, LD 2387 a "Resolve Creating the Commission on Marine Research" was introduced and referred to the Joint Standing Committee on Marine Resources. The committee reported out the bill Ought to Pass as Amended with Committee Amendment A (H- 617).

As reported out of Committee, the bill set up the Commission on Marine Research to do the following:

1. Identify the areas of marine-related research conducted at federal, state and private institutions and the level of support;

2. Outline the degree of cooperation and coordination between the various research institutions operating within the State;

3. Develop a compendium of research gaps and needs and solicit information, advice and recommendations for state-supported marine research; and

4. Develop recommendations for state actions and funding to support this policy and program.

In the final days of the second regular session, the bill was amended in the Senate (S-537) to strike out this language, leaving only the emergency preamble and an appropriation.

This report is a product of the deliberations of the Commission on Marine Research. Where possible, this report follows the intent of the bill as reported out of committee.

The commission held a public hearing in July and met several times over the summer and fall of 1988. A working group composed of marine researchers has developed a preliminary set of research needs to address in the Gulf of Maine. Three submissions are attached in appendix B.

2. Senator Mitchell's Bill

In the 100th Congress, Sen. George Mitchell introduced S. 2068, a bill to "Amend the Marine Protection, Research and Sanctuaries Act to Protect Marine and Near-Shore Coastal Waters through Establishment of Marine Research Centers". The purpose of the bill was to:

1. Expand and improve research and monitoring of marine and coastal waters to understand how these systems work and how human activities affect them;

2. Coordinate marine and coastal research at the regional level; and

3. Expand and support research at the regional level.

The bill proposed to establish 10 regional marine research programs and to develop comprehensive reports on the conditions, trends and needs in the marine environment. These programs were envisioned to set overall research goals for the region, develop comprehensive long range plans, monitor and report on environmental quality in the region, provide for public input into their activities, and coordinate research activities both within the region and with other regions. As proposed, the bill had an appropriation of $33 million from the Marine Research Trust Fund. While the bill was not passed during the 100th Congress, Senator Mitchell plans to reintroduce it in the next session.

The Gulf of Maine is one of the regions proposed within the bill. The creation of a Marine Research Board as proposed by the Commission, would position Maine to take a lead role in the Gulf's regional program.

III. FINDINGS

The Commission on Marine Research puts forth the following findings in support of proposed legislation:

1. The Gulf of Maine is a resource of tremendous importance to the State both ecologically and economically.

The rich resources of the Gulf of Maine provide habitat for fish, shellfish and wildlife, opportunities for aquaculture, an avenue for commerce and important recreational values.

In addition, preliminary estimates of Maine's marine industry indicate that it employs over 24,000 people with a value-added contribution of over $792 million to the state's economy or 4% of the Gross State Product. The aesthetic and recreational values of the coast, while not readily quantifiable, also contribute greatly to our economy and Maine's quality of life.

2. Resources in the Gulf of Maine are experiencing problems from both human-induced and natural changes.

There is a growing awareness and concern for environmental problems in the Gulf of Maine. Once thought to be a relatively pristine environment, reports of high levels of hydrocarbons and PCBs in Casco Bay paint a different picture. Nearly 30 million gallons of treated sewage and 22 million gallons of industrial wastewater flow into the Bay each day; 67 tons of toxic metals and 1500 tons of petroleum-related hydrocarbons end up in the bay each year. PAH (Polycyclic Aromatic Hydrocarbon) levels found in sediments from outer Casco Bay were the fourth highest in a nationwide study of bays and estuaries. Mussels from Casco Bay sampled in a national EPA survey contained levels of hydrocarbons that were the highest found in the Northeast.

Further up the coast, the appearance off Prince Edward Island of a lethal dinoflagellate bloom coupled with an unexplained plankton bloom in Maquoit Bay, which killed 40% of the organisms in the bay's flats, highlight the dearth of information on our resources and the intense need for more research.

Commercial fish landings are declining without a clear cause. Shellfish harvesting areas throughout the coast are closed because of bacterial pollution levels and the presence of toxins. While the values of the coast attract population and tourism growth, their presence increases contamination and related environmental problems in our coastal waters. Discharges from sewage treatment plants and disposal systems and run-off from urban areas and construction sites contribute to marine pollution.

3. We do not know enough about basic physical and biological systems in the nearshore waters and the Gulf of Maine to know how much stress they can tolerate, what effects further human alterations will have and what actions would best restore and protect them.

The ecological systems of the Gulf are complex and interrelated. The effects and magnitude of resource management decisions (land use or fisheries management for example) are not now predictable. We need to understand the dynamics of both the physical and biological resources of the Gulf if we are to manage effectively our use of those natural resources.

For example, one of the foremost issues for the coming decades is an expected change in sea level. Resource managers must anticipate and plan for sediment and erosion problems accompanying any predicted rise in sea level. The information to do this does not now exist.

4. A variety of programs and institutions conduct marine research within the state funded primarily by the federal government. However, there are limited means to support coordinated research addressing problems of importance specifically to Maine. In addition, recent trends have shown a decline in marine research funding from federal sources.

Sea Grant, the University of Maine System, DMR and several other institutions are working to address concerns in the marine environment. ARGO Maine, a consortium of research organizations, has been working to coordinate research among its members. However, there are not adequate funds to develop the broad research programs the resources in the Gulf deserve or even the research programs Maine people need to protect their future.

Research monies available through the Sea Grant Program have decreased since 1980. Adjusted for inflation, funding has declined by almost 45%, from approximately $475,000 in 1980 to $275,000 in 1988 (1982 dollars).

DMR's federal funding through the Anadramous Fisheries Restoration Act has remained funded at about $50,000 per year through the 1980s, while their Interjurisdictional Fisheries Act monies have also decreased by over 25%, from $212,500 in 1980 to $169,268 in 1988. Adjustments for inflation would make this even more dramatic.

Federal funding for marine pollution monitoring nationwide has fallen from $147 million in 1982 to $111 million in 1988. These figures also are not adjusted for inflation.

The National Science Foundation's (NSF) Experimental Program to Strengthen Comprehensive Research (EPSCOR) had $3 million budgeted for marine research in Maine between 1980 and 1985. While the EPSCOR program is being revived in Maine through the Maine Science and Technology Commission and the University, its focus will be much broader and will target support systems for more general research within the state.

5. Marine research institutions in the state have basic facility constraints that must be addressed to enable them to continue to carry out high caliber marine research in the Gulf of Maine.

DMR and Bigelow Laboratory have major space constraints at their facilities on McKown Point. In addition, many of the offices and laboratories on the Point are out of compliance with OSHA standards. Other research institutions also have problems with their facilities.

There has not been an overall review of the range of marine research facilities and needs within the state to guide planning and funding decisions.

6. The University of Maine System has a shockingly inadequate marine research program considering the importance of the coast and ocean to Maine. A special Task Force on Marine Activities within the University of Maine has urged the University to strengthen its activities and organization in the marine field. The changes and actions they suggest are much-needed to increase the effectiveness of the University in marine activities.

The University does not have an oceanography department and many of the faculty within the Center for Marine Studies are shared with other departments. The University also does not offer any undergraduate degree programs in the marine field. The State university's commitment to Maine's marine resources is very low considering the importance of Maine's ocean and quality of life.

A special task force within the University of Maine has recommended increasing emphasis by the University on marine activities. The report of the task force, endorsed by President Dale Lick, contains 33 major recommendations to strengthen the marine studies organizational structure, strengthen the University's position as a partner in marine research activities, and continue the development of a broad-based academic program in marine studies. The strongest recommendations are for the University to establish a Department of Oceanography within the College of Sciences and to stress the importance of a state match for the Sea Grant College Program.

7. The Bureau of Marine Science within the Department of Marine Resources is partially supported by federal funds. Recent trends have shown a decline in federal funds: three federally funded positions were recently lost and 10 more positions within the Bureau remain vulnerable to further reductions in those funds. This dependence undermines the long-term consistency and stability needed for an effective research program.

Funding for DMR's total activities in FY1988 totalled $1.9 million of which 72% came form the general fund, 22% from federal sources and 6% from other sources. However, more than one-third of the scientific staff and two-thirds of the support staff in the Bureau are funded by the federal government. Last year, three scientific positions were cut from federal funds.

8. The Bigelow Laboratory of Ocean Sciences is the largest private marine research organization in Maine, providing unique research capabilities important to Maine and attracting significant out-of-state funds and world-wide prestige to Maine. Yet lack of funds for basic institutional support and its dependence on temporary grant funding jeopardizes the future of its contribution to solving Maine's marine resource problems.

Bigelow Laboratory is a private, non-profit organization that undertakes basic research in biological oceanography. Bigelow has unique capabilities in the state for culturing marine phytoplankton (important for quickly identifying algal blooms), remote sensing of the oceans and flow cytometry.

The Lab's main source of income is research grants from federal agencies. In 1974, that income was $200,000 whereas in 1987, the Lab received $2.2 million in research grants. Bigelow Labs receives an annual state appropriation of $100,000 per year, representing 4% of its operating budget. However, it is the only firm source of income to provide financial stability for the Lab. This overreliance on "soft money" has meant that, at times, professional researchers have foregone their salaries for lack of funds.

9. Basic and applied research are important to managing and understanding the dynamics of the Gulf of Maine, as well as managing the impacts of growth and pollution on the quality of Maine's marine environment. Mapping and monitoring programs undertaken by state agencies and private organizations provide vital information for these research efforts. Yet these programs are skimpy and poorly funded.

The main emphasis of the Commission's work has been to try to develop a mechanism to identify and fund basic and applied marine research needs in the Gulf of Maine. Monitoring and mapping of the marine environment is essential to sound marine research and sometimes is research in itself. Present state efforts at mapping and monitoring the marine environment fall far short of the State's needs if we are to manage our resources well.

IV. RECOMMENDATIONS

In response to these findings, the Commission has proposed legislation for introduction into the one hundred and fourteenth Legislature that will:

1. **Create a Marine Research Board within the Maine Science and Technology Commission to identify and fund marine research needs within the Gulf of Maine.**

   As proposed the Board would (see Appendix A):

   - develop a research priorities statement with an action plan designed to guide the board in its funding decisions;
   - administer a grants program focused on basic and applied research in the marine environment;
   - have staff to implement and administer the program;
   - be composed of the major users of or contributors to the field of marine research; and
   - identify facility needs.

2. **Fund positions within DMR's Bureau of Marine Sciences that are currently federally funded from the General Fund. These positions include six scientists, a clerk typist, a word processing operator, a technician and a carpenter.**

   Funding these positions from the General Fund would:

   A. Stabilize these positions in a time of shrinking federal funds (3 positions were cut last year), and

   B. Allow DMR to use the freed federal funds for specific marine-related projects.

3. **Fully fund the librarian and assistant librarian positions at DMR's McKown Point library. Half of each position is now paid for by Bigelow Laboratories for the Ocean Sciences. Full state funding would allow Bigelow's portion of this funding to be put toward the Laboratory's other critical needs.**

   The costs of supporting the Library on McKown Point are increasing. This facility, shared with DMR, is open to the public. Bigelow's costs are now approximately $40,000 which supports personnel within the Library.

In addition, the Marine Research Commission recommends:

1. **The current appropriation to Bigelow Laboratory be continued or expanded. The Commission also supports consideration of appropriations to other private organizations, for example the Mount Desert Island Biological Laboratory whose marine research missions are of importance to the state.**

   Bigelow Lab currently receives an annual $100,000 appropriation from the State of Maine. While this is only 4% of their operating budget, it does provide a measure of financial stability in an era of shrinking federal funds. The lab uses the Gulf of Maine as their laboratory, contributes to research of importance to the state and possesses unique research capabilities such as remote sensing and algal culture. The scientists are a source of expertise in various aspects of marine science and are active in public education and information efforts. In addition, the existence of a strong private lab makes for a pluralistic marine research community in Maine.

2. **The University of Maine's Task Force on Marine Activities report to President Dale Lick should be implemented without delay. This report makes solid recommendations to upgrade the University's role and effectiveness in the field of marine research and that effort should be supported. Specifically, the Commission supports the recommendation stressing the importance of a state match for the Sea Grant College Program.**

   As mentioned in the findings section, this task force has recommended 33 much-needed changes to give the University a more effective marine program. These changes should be implemented as soon as possible.

3. **Marine mapping and monitoring programs undertaken by state and private organizations. While the bill proposed by the Commission is focused on basic and applied research, continued monitoring and mapping efforts within the Gulf are essential to understanding our marine environment and the Commission strongly recommends increasing state support for this activity.**

   The Commission recommends increased support for mapping and monitoring efforts to position Maine to deal with current and future problems.

APPENDIX A

PROPOSED LEGISLATION

APPENDIX A
PROPOSED LEGISLATION

DRAFT

FIRST REGULAR SESSION

ONE HUNDRED AND FOURTEENTH LEGISLATURE

Legislative Document No.

STATE OF MAINE

IN THE YEAR OF OUR LORD
NINETEEN HUNDRED AND EIGHTY NINE

AN ACT to Promote Marine Research.

Be it enacted by the People of the State of Maine as follows:

Sec. 1. 5 MRSA, § 12004, sub-§ 8, P 19-C is enacted to read:

(19-C) Marine Resources	Marine Research Board	Expenses only	12 MRSA § 6271

Sec. 2. 5 MRSA, sections 13127, 13128 and 13129 are enacted to read:

§13127. Marine Research Board.

The Marine Research Board, as established in chapter 379, hereafter referred to as the board, shall carry out the purposes of this chapter.

1. Purpose. The board shall identify basic and applied marine research needs within the Gulf of Maine of interest to the state and shall develop a competitive grants program to address those needs. The board also shall work to foster cooperation between marine research agencies and institutions to efficiently carry out marine research. The board's focus shall be on basic and applied scientific research rather than technological development or technology transfer. The board shall coordinate its activities with the commission.

2. Composition. The board shall be composed of 13 members. The membership shall include a representative of the University of Maine System, a representative of ARGO Maine, one member representing nonprofit environmental organizations, one member representing independent higher education institutions, two members representing the scientific community, and two members representing marine resource industries. The Commissioners of the departments of Environmental Protection, Conservation, and Marine Resources, the Director of the State Planning Office and the Director of the Sea Grant College Program shall serve as ex-officio members.

2. Appointment. The Governor shall appoint all members of the Board, subject to review by the joint standing committee of the Legislature with jurisdiction over marine resources and to confirmation by the Senate. The Governor shall appoint the chairperson annually.

3. Terms. Appointed board members shall serve for 3 year terms. Initial terms shall be 3 members for one year terms, 3 members for two year terms and 3 members for three year terms.

4. Compensation. Board members that are not representing state agencies shall be compensated for their expenses in accordance with chapter 379.

5. Number of terms. Board members may serve no more than two consecutive terms.

6. Quorum. A quorum shall consist of 7 members. A quorum shall be necessary for the board to conduct its business at any board meeting.

7. Rules for the board. The commission shall consult with the board in the establishment of any rules relating to the board and their activities.

8. Staff. With the advice of the board, the executive director of the commission shall employ professional staff to administer and implement the programs and policies of the Marine Research Board.

§13128. Powers and duties of the Marine Research Board.

1. Research Priorities Statement. The board shall develop a biennial priority statement and action plan of marine research needs in the state of Maine. The statement will be submitted to the Governor and the Legislature no later than January 1 of each even-numbered year, except that the first statement shall be prepared by July 1, 1990. This statement and plan shall guide funding decisions and activities of the board. The board shall hold public hearings to gain insight into marine research needs for the state.

2. Data base. The board shall develop, maintain and periodically publish a bibliography of relevant research within the Gulf of Maine. The board also shall encourage integrated data management for data relating to Maine waters and the Gulf of Maine.

3. Facility needs. The board shall develop a facility needs plan for the support of marine research within the State of Maine that shall identify and focus attention on specific facility needs with the objective of fostering cooperation within the marine research community. The plan shall be finished by October 1, 1990 and may be developed with the help of contractual services. This plan shall not prohibit agencies from addressing specific safety problems within their facilities.

4. Other activities. The board also may sponsor and conduct conferences or publish periodic reports relating to marine research.

5. Cooperation. The board shall strive to coordinate its programs with existing policies and programs within the field of marine research.

§ 13129. Marine Research Grants Program.

The board shall develop and administer a competitive, merit-based grant program to address marine research needs for the state of Maine as set forth in section 13128, subsection 1.

1. Granting criteria. The board shall develop, and the commission shall approve, criteria for awarding grants under this program. Criteria shall include but not be limited to the quality of the research proposal and the ability of the organization to carry out the proposed research.

2. Peer Review. All proposals for funding shall be subject to peer-reveiw by a panel of experts in the field of

marine research that are not employed by or affiliated with marine research institutions within Maine. The commission, upon recommendation from the board, may contract with another entity to coordinate the peer-review process.

3. Granting decisions. The board shall make the final decision for awarding grants under this program. The board shall competitively evaluate and may award grants that conform to the granting criteria and are consistent with the research priorities statement and action plan developed under section 13128.

Sec. 3. Appropriation. The following funds are appropriated from the General Fund to carry out the purposes of this Act:

	1989-90	1990-91
MARINE RESOURCES, DEPARTMENT OF		
Marine Sciences, Bureau of		
Positions	(5)	(10)
Personal Services	$ 178,555	$ 323,066
Provides funds to allow for the transfer of positions from federal funds to the General Fund.		
Marine Sciences, Bureau of		
Positions	(2)	(2)
Personal Services	43,915	58,550
All Other	(14,672)	(19,562
Provides funds for a Librarian III and a Library Assistant. The funding for these two positions is currently shared between the Department and Bigelow Laboratory. This results in a $29,243 increase in FY1989 and a $38,988 increase in FY1990.		

Sec. 4 Allocation. The following funds are allocated from the Federal Expenditures Fund to carry out the purposes of this Act.

	1989-90	1990-91
MARINE RESOURCES, DEPARTMENT OF		
Marine Resources Sciences		
Positions	(-5)	(-10)
Personal Services	$(178,555)	$(323,066)
All Other	178,555	323,066

Reallocates federal funds currently used to support 5 positions in Fiscal Year 1990 and 10 positions in Fiscal Year 1991 to provide additional funds for anticipated marine research activities within the Department.

Sec. 5 Appropriation. The following funds are appropriated from the General Fund to carry out the purposes of this Act.

	1989-90	1990-91
EXECUTIVE DEPARTMENT		
Maine Science and Technology Commission		
Positions	(2)	(2)
Personal Services	$ 48,524	$ 64,699
All Other	52,500	1,559,250
Capital Expenditures	1,500	
	$102,524	$1,623,949

Provides funds to establish a Marine Research Board within the Maine Science and Technology Commission. These funds shall be used for professional staff, a Clerk Typist II and general operating expenses to administer the Board. In addition, this appropriation provides $40,000 in Fiscal Year 1990 for contractual services to develop a facility needs plan, $50,000 for Fiscal Year 1991 for contractual services for peer review of research proposals, and $1.5 million in Fiscal Year 1991 for the proposed marine research grants program.

APPENDIX B

MAINE'S MARINE RESEARCH NEEDS

REPORT TO
THE COLES LEGISLATIVE COMMISSION ON MARINE RESEARCH
ON
MAINE'S MARINE RESEARCH NEEDS[1]

SUMMARY

The wisdom with which Maine makes future policy decisions on important marine issues will increasingly depend on the degree to which it reaches a proper scientific understanding of the workings of the Gulf of Maine and its coastal waters. The promises -- and threats -- that the future holds for Maine's marine resources rest on the very premise that our decisions will be explicit rather than judgmental, and will thus depend upon the quality of information in hand. The need for the best scientific information obtainable has never been more urgent as underscored by recent events, including:

- Declining fish landings;
- Closures of shellfish harvesting areas;
- Reports of toxic substances in bottom sediments;
- Unexplained plankton blooms;
- Rising sea level and shoreline erosion.

With the coast of Maine facing inevitable pressures of continuing development it becomes all the more important that we:

- provide much-needed infrastructural support for our marine research institutions, and;

- develop and maintain a coordinated, comprehensive and sustained program of state-sponsored marine research in the interests of Maine.

The goal of a research program should be to provide the best scientific information possible with respect to:

(1) changes in water quality and biological resources of the marine environment that result from human activities and natural causes such as climatic variation;

(2) potential threats to human health resulting from the accumulation of naturally occurring toxins and pollutants in seafood;

(3) proper management of natural resources, including improved predictive capabilities.

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[1]/ This document is the result of discussions among: the Maine Department of Marine Resources, the Mount Desert Island Biological Laboratory, the University of Maine, Bigelow Laboratory for Ocean Sciences, Bowdoin College, the State Planning Office, the Department of Environmental Protection, the Maine Geological Survey, the Department of Inland Fisheries and Wildlife, the Maine Sardine Council, and Maine Maritime Academy.

State marine research funds will:

- allow priority research and monitoring to be conducted, and thus;
- enable Maine to make full use of its considerable scientific talent;
- provide match for federal funding not now coming to Maine;
- insure that Maine will be ready to meet unexpected environmental crises.

A council should be appointed which has a full-time executive director and staff person, and which includes representatives from ARGO-Maine, industry, state government, and the Maine Sea Grant College Program. The council should have the responsibility and authority to:

- set priorities and coordinate marine research activities ;

- award state-funded grants on a peer-reviewed, merit basis and in keeping with the state's goals;

- report results of the program to state and local officials and interested parties;

- the council should take advantage of and not duplicate the administrative structure and the education and support services of the Maine Sea Grant College Program.

Funding for the council, including the research grants and administrative costs, should be 1.5 million dollars annually.

I. Introduction

The Gulf of Maine and its waters along our immediate coast represent a natural resource of immeasurable value to the people of the State of Maine. No one would disagree that wise management and conservation measures are required if these waters are to retain their value when passed on to future generations. But the formulation of rational management policies can never be any better than the scientific information made available to the decision-makers, and it is unfortunate that in many instances the quality of that scientific information is inadequate to explain observed changes in the marine environment. Examples around the country of troubled, mismanaged waters are many, including such notorious examples as Chesapeake Bay, Long Island Sound and Boston Harbor, but the waters off our shores are not presently in such a sorry condition. In comparison, our marine environments are relatively healthy. But without responsible foresight, the quality of coastal waters can only deteriorate.

The tendency for most of us is to respond to crises and not to anticipate them. This attitude of complacency welcomes the unexpected -- and nearly always costly -- end products of such inattention; such an attitude continues unchecked even in the face of numerous early warning signs. Recent trends in the Gulf of Maine, such as declining fish landings, closures of shellfish harvesting areas, reports of toxic substances in bottom sediments, rising sea level and shoreline erosion, and unexplained plankton blooms, have served to heighten appreciation of our marine waters and to underscore the need to manage wisely our various marine resources. But the present store of scientific information on the Gulf of Maine and its coastal waters is, unfortunately, out of step with growing demands for explanations of how to interpret changes and threats to the marine environment. All this comes at a time when federal funds for coastal research are becoming increasingly difficult to obtain, and, ironically, when the field of marine science is at the same time benefiting from technological advances which can be used to address a wide range of environmental problems. Clearly, the time is at hand to scrutinize policies for scientific research on the Gulf's waters and their resources, and to develop a research strategy for the 1990's.

In this assessment report we recognize the tremendous breadth of the marine related research needs of importance to Maine. They range throughout and perhaps beyond the issue areas of "Fisheries Management and Development, Changes in the Coastal Environment, and Industry and Commercial Development" as described in the 1986 UNH/UM Sea Grant Long Range Plan. They require the application of diverse talents from many disciplines, including: economics, law, engineering, natural science, sociology, policy, etcetera. In this, however, it is important to recognize that all of these marine issues and related research needs are derived from a natural system: the Gulf of Maine. Thus, our understanding of how that system operates in its natural state -- and how it may be perturbed by us -- is of first-order significance and underlies all of these derivative needs.

Research for developing an understanding of the Gulf of Maine represents a continuing, long-term need for the State. Such research can be considered both basic and applied in that it will be driven by a mixture of intellectual curiosity and one or more of the numerous important practical issues confronting the State. These latter include marine pollution in all of its myriad aspects; fisheries management, both capture and culture; and many aspects of recreation, tourism and coastal development. The critical points to be recognized are that: (1) understanding how the Gulf of Maine works as an interactive physical, chemical and biological system is essential for effectively dealing with these practical issues over both the short and long haul; and (2) to develop this understanding requires field observational and experimental research on the Gulf of Maine. Such research is costly and to be most effective will require a long-term commitment of resources, close coordination in its planning and implementation, and continuing communication with those who need or can use the data, information and understanding as they are acquired.

The purpose of this report is to identify important areas where more research on the environment and living resources of the Gulf of Maine is needed, and to recommend actions for the State of Maine, namely: a) to strengthen the infrastructure of our research institutions in order to provide a sound footing for the highest quality research, and b) to create a source of new funding for Maine scientists to conduct relevant research in an efficiently coordinated and interrelated fashion in order to best meet the growing needs of all who deal with marine issues in our state. Toward that end we propose here a programmatic approach for Maine to deal with the much-needed marine scientific research in the coastal and offshore waters of the Gulf of Maine.

II. Gaps in our scientific understanding of the Gulf of Maine and its coastal waters, and a program for future research:

Despite the capability for quality marine research and monitoring by Maine marine scientists we are, in fact, only skimming the surface of the many new areas of research that continue to arise and it is clear that there are a number of research needs not now being met. Unfortunately, the majority of those areas for which research is most needed do not easily lend themselves to federal research grant applications, in that they suffer from being too regional in nature and do not reflect national priorities or global significance. If Maine is to arrive at its goal of a proper scientific understanding of the marine environment, the initiative to begin such studies must be taken by our own state government.

Maine's basic marine research need is twofold: there needs to be better infrastructural support for our various research facilities - government, academic and private - and there must be a new, reliable source of funds with which to conduct the actual research. The three sections below argue for a set of research priorities facing Maine from its nearshore waters to the open Gulf of Maine. Highest priority should be attached to those issues closest to our shores. Each issue raised, however, must be approached as part of an overall

research program to provide answers to priority questions outstanding today, and to have the expertise ready to respond to future problems.

Maine's Estuaries and Nearshore Environment

Nowhere on the east coast of the U.S. is the land-sea interface as complex as it is here in Maine and it is along this long and winding shoreline that terrestrial influences are transmitted. The most obvious terrestrial influence on the marine environment is river runoff.

The importance of fresh water runoff into the Gulf of Maine via numerous estuaries has never been directly assessed by a well designed, inter-disciplinary research effort. The early work of Henry Bigelow showed that the spring discharge of winter melt-waters is responsible for the intense westerly-flowing coastal current along the northern Gulf and, as he pointed out, the annual discharge from only four of these rivers (Penobscot, Kennebec, Androscoggin and Merrimack) amounts to enough fresh water to raise the level of the entire Gulf of Maine by 1.5 feet per year. This ignores the largest river emptying into the Gulf, the St. John, as well as all the other minor rivers and streams. The effects of freshwater additions on the physics, chemistry, biology and geology of the Gulf of Maine are poorly understood.

Responses in the marine environment to perturbations resulting from recent increases in population growth and economic development along our coasts will be felt first by, and communicated to, the coastal waters along the land-sea interface demarcated by Maine's countless estuaries, bays and inlets. It is via our rivers and streams that most pollutants enter coastal waters, yet we know very little about the process of physical mixing and dispersion or the chemical transformations of such substances in the dozens of estuaries in Maine.

In addition to being pollution pathways, estuaries are themselves extremely productive ecosystems. Examination of the Maine coast reveals the abundance and diversity of our estuarine systems, and serves to underscore their importance. Just how productive these estuaries are, and how they contribute to the total production of the Gulf of Maine remain unknown. Speculation on their role as nursery areas for larval fishes, for instance, can only be resolved through more detailed research efforts than have been reported to date.

Sets of priority questions are:

1. What is the relative importance of the nearshore environment in overall biological production, given the high coastline length to water volume ratio of these systems? What fraction of overall production is retained within the nearshore environment, as compared to that exported into the coastal zone?

2. To what extent do estuaries act as filters to substances entering from rivers and streams, such as pollutants and nutrients, and prevent their passage to the coastal zone? How vulnerable to

different pollutants are the various estuarine systems? Where are trapped pollutants likely to accumulate?

3. What are the mixing and flushing regimes of these estuaries? What is the capacity of these inshore areas to assimilate additional anthropogenic nutrient loads?

4. What effect would proposed hydroelectric dams have on the suspended sediments loads which now reach the coast? Would the delivery of dissolved nutrients (from the rivers or by compensatory upwelling of coastal waters) be affected? Would the spring plankton blooms in the coastal waters, which are so important to the benthos and meroplankton (and hence to our fisheries), be adversely affected as a result of damping the spring pulse in freshwater runoff? What would be the effect on coastal erosion?

5. How does the circulation in estuaries and nearshore waters affect sediments? What is the pattern of sediment movement, dispersal and burial in estuaries and nearshore waters? How much suspended load and bed load reach the coast via export from estuaries? How permanently are polluted sediments buried?

6. What processes control the accumulation of chemical pollutants in the sediments of our nearshore waters? Are these substances biologically available? What causes blooms of dinoflagellates, such as those responsible for the recent shellfish kill in central Maine? Does some form of pollution cause them? Are they more common than we realize? Just what are the ecological effects we can expect fop particular pollutants and combinations of pollutants? What species now occur in the Gulf; do we have a reliable inventory? What do we presently know about the health, reproductive biology and pathology of our marine organisms? How do physiological processes affect and modify the bio-accumulation and bio-transformation of pollutants?

7. How do storms affect the shoreline and nearshore environments? Are storms the major agents of coastal re adjustment to long-term changes? Are storms likely to disturb dredge spoil dump sites?

8. What effects do commercial harvests of nearshore shellfish species have on marine wildlife species which make extensive use of these areas? What presently typifies the nearshore environment as may be referred to in cases of suspected alterations?

This list of questions highlights some of the more obvious areas in need of further research. Until we understand those processes occurring in the estuaries and near-shore waters, we can hardly expect to appreciate fully their influence on our marine resources or the oceanography of our coastal shelf waters.

The Gulf of Maine Coastal Waters

Beyond the estuaries themselves, in the roughly 20 mile-wide band of coastal waters of the Gulf of Maine, the influences of freshwater additions continue to be felt but are only poorly understood. This zone contains a mixture of low salinity estuarine waters and higher salinity offshore waters; the resulting density gradients drive a highly variable coastal current along the northern Gulf and affect the Gulf-wide circulation pattern. Also, enhanced vertical stability and nutrients derived from a combination of river and offshore waters in the vicinity of estuarine and upwelling plumes can be expected to be sites of sustained phytoplankton bloom conditions. The benthic habitat in the coastal zone is heterogeneous, ranging from exposed and submerged rocks to featureless, soft, mud bottom. Considering the extensiveness of estuaries along the northern Gulf and their apparent influence in the biological productivity of nearshore and coastal waters, it is not surprising that much of the production of fishable biomass occurs within 20 miles of the coast and inside the 100 m isobath; the linkages between this coastal production and estuarine-nearshore processes represent areas in urgent need of further scientific study.

Sets of priority, unanswered questions include:

1. What is the rate of coastal erosion/retreat and how much of it is controlled by sea-level rise?

2. What is the composition of the sea floor and how does the spacial variability in substrate influence: a) biological habitat, b) the physical stability of the environment, c) the capacity of the environment to absorb/bury pollutants? Are there unique geologic environments that deserve protection from ocean dumping?

3. What are the effects of varying river discharge on the physics of this zone? To what degree does freshwater discharge influence the forcing of coastal currents and the delivery of dissolved and particulate matter to the coastal waters and beyond? How can controlled river discharge, such as might result from extensive damming of rivers, affect the manner in which freshwater influences the coastal density field, and hence vertical mixing and estuarine-like coastal circulation? How do upwelling and the formation of fronts respond to freshwater input? How do wind mixing events and tides affect the "spreading" of fresh waters along the coast and thus modify the density field?

4. Do these discharges result in enhanced nutrient delivery, local upwelling, increased vertical stability, and/or salinity fronts which augment biological production?

5. Does the resulting production get shunted more efficiently through the benthos and thus help to explain coastal Maine's productive ground fisheries for vertebrates and invertebrates?

6. What are the cues that induce movement of commercial species, and the processes which control the transport of living organisms between estuaries and the coastal zone? What are the effects of different sediment types and processes (e.g. dragging) on habitability for various species?

7. How does the recently described eastern Maine coastal current and plume of tidally-mixed and upwelled waters influence such things as: interannual variations in the Gulf of Maine nutrient budget? Eastern versus western Gulf patterns of production? Advection of fish larvae, particularly herring?

The processes occurring in nearshore and estuarine waters would seem to be closely coupled to the coastal waters and visa versa, but we can only speculate as to how one system might respond to natural and artificial perturbations in the other. Moreover, the gaps in our knowledge do not end here; the productive coastal waters are also closely linked to oceanic and offshore Gulf of Maine waters.

The Open Gulf of Maine

Beyond the 100 m isobath of the Gulf of Maine are the deep basins and offshore banks and ledges. Though generally not as productive as the coastal water (excepting the shoal areas) these waters are sites of important exchange processes and seasonally productive events.

Most of the exchanges of water into and out of the Gulf of Maine occur through the Northeast Channel, a deep water access just east of Georges Bank. Waters which enter the Gulf through this channel do so at depth and hence bring with them a rich supply of essential inorganic nutrients. As much as half of this nutrient load comes to the surface in a very small area in the Grand Manan area, forming the coastal current/plume discussed above. Many have speculated that the magnitude of this delivery of nutrients may in fact dictate the level of biological production in the entire Gulf. We still do not know, for instance, what the seasonal rates are of such influxes of oceanic waters, nor do we know to what extent these waters mix with surface waters in other parts of the Gulf and at various times of the year to become available for photosynthesis. We do know that the vertical mixing of Gulf of Maine waters is very significant during winter; thus some of these nutrients which enter the Gulf are present when the spring bloom develops. But what is the ultimate fate of this admittedly huge amount of nutrients and subsequently fixed organic carbon? Do we see this reflected in our coastal fisheries?

We very much need to carry on where Henry Bigelow left off, and to continue to investigate the oceanography of the offshore waters of the Gulf of Maine, to identify the important water motions which dictate nutrient delivery and transport materials, and to assign values to exchange processes which must regulate biological production.

Sets of priority questions which remain outstanding to this day are:

1. What are the pathways for deep ocean water, and hence nutrient delivery to surface waters of the Gulf where they drive photosynthesis? What is the important interplay between vertical mixing and the springtime increase in daylight that cues the onset of the spring bloom? What is the magnitude of the low level but extensive primary production that occurs throughout the Gulf?

2. To what extent might the coastal zone serve as a sink for the primary production of the open Gulf waters? Conversely, how important are the open Gulf waters and sediments as sinks for coastal production? Does the open Gulf act as a site of seasonal refuge for certain species, such as shrimp and juvenile herring?

3. How significant are Gulf-wide plankton blooms as compared to near-shore and coastal production? How much of the production in each of these areas is consumed in the water column? How does water column production fuel production in the benthos?

4. What are the processes which control recruitment of commercial species?

5. What is the role of Gulf-wide nepheloid layers in distributing associated nutrients and pollutants?

6. How do Gulf stream eddies, which occur outside the Gulf of Maine and effectively set up a pressure head, affect the influx of nutrient-rich and dense bottom water into the Gulf of Maine? Is this a seasonally or interannually variable phenomenon?

These questions are in no way complete; our understanding of the offshore Gulf of Maine waters is insufficient to warrant extending this list further. But additional questions, and we hope, meaningful answers will surely follow-answers which will provide the framework within which we can feel more comfortable in dealing with the environmental issues of our time.

III. Recommendations:

1. We recommend that attention be given to the needs for better infrastructural support at our marine research institutions, and that each institution prepare a detailed plan for improvement.

The combination of State, Academic and Independent marine research institutions in Maine represents a powerful combination of disciplines to tackle the many research issues facing the state. Each has its own sets of expertise and working together we can maximize limited resources. But for such cooperative research efforts to come about, and for Maine to meet the challenges facing our marine environments, we must allow our scientists to make full use of their talents in the pursuit of the above sets of questions.

This means that we must face the need for better equipped, better funded levels of basic support at our major institutions.

2. Given the diversity of expertise at our marine research institutions we should not compete with one another in budget battles for limited state resources, but rather we should agree to such a set of priorities as outlined here, to set up a mechanism, such as a marine research council, to make available and award state funded research grants to scientists at our own institutions.

To meet the need for additional research funding to address the priorities we have set forth here, we recommend that a marine research council be formed to re-grant State funds in a peer-reviewed, merit basis for those research proposals which are directed at the above priorities. We believe that it is the duty of Maine to shoulder the responsibility to meet the research needs facing the state for which federal funds are scarce. The council should have a full-time executive director and staff person, and include representatives from ARGO-Maine, industry, state government, and the Maine Sea Grant College Program. The council should have the responsibility and authority to:

- set priorities and coordinate marine research activities in Maine;
- award state-funded grants on a peer reviewed, merit basis in keeping with the state's goals;
- report results of the program to State and local officials and interested parties;
- the council should take advantage of and not duplicate the administrative structure and the education and support services of the Maine Sea Grant College Program.

Funding for the council, including the research grants and administrative costs, should be 1.5 million dollars annually.

STATE OF MAINE
Department of Environmental Protection

MAIN OFFICE: RAY BUILDING, HOSPITAL STREET, AUGUSTA
MAIL ADDRESS: State House Station 17, Augusta, 04333
207-289-7688

JOHN R. McKERNAN, JR.
GOVERNOR

DEAN C. MARRIOTT
COMMISSIONER

MEMORANDUM

DATE: November 18, 1988

TO: Commission on Marine Research

FROM: John Sowles, Biologist, Maine D.E.P.

SUBJ: Marine Research Priorities

*** *** *** *** *** *** *** *** *** ***

Perhaps the best way we can suggest marine research priorities for the Commission on Marine Research, is to outline what we, a public service agency in direct contact with the public, see as needed to properly fulfill our legislated responsibilities.

Established by the Legislature, The Maine Department of Environmental Protection ..."shall protect and improve the quality of our natural environment and the resources which constitute it and shall enhance the public's opportunity to enjoy the environment by directing growth and development which will preserve for all time an ecologically sound and aesthetically pleasing environment."

By statute, the D.E.P. is charged with protecting more of Maine's environment than simply those components with exploitational value or public health implications. The premise for this is sound, in that, if the environment is protected, commercial resources and public health will, with but few exceptions, be well served. Aesthetic and recreational opportunities are as much a part of Maine's quality of life as safe drinking water. Their protection is consistent with the intent of the Legislature and the federal Clean Water Act. If our initial focus is public health or a commercially valuable resource, then by the time effects are found serious ecological problems may already exist. Accordingly, we strongly disagree that marine research priorities should be limited to public health and commercial fishery issues, although these certainly are high priorities.

Among the many laws administered by the D.E.P., the Water Classification program is probably the hub around which most, if not all state water laws are formed and is at least part of the basis for many other state laws affecting landuse, development, waste disposal, habitat alteration, etc. The classification program is actually the State's management plan for all Maine's waters and the means by which we comply with the federal Clean Water Act. The goal of our program is to "restore and maintain the physical, chemical and biological integrity of the State's waters and preserve certain state waters in their natural condition."

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The primary means by which the D.E.P. achieves its classification goals is through licensing and enforcement of performance standards as well as ambient monitoring of receiving waters. Proper management of licensed activities assumes an adequate understanding of the activities and their effect on the environment. Too often, however, actions must be taken before sufficient information is available resulting in the trading of one problem for another, ineffective or sometimes inappropriate regulation. To achieve our statewide water management goals, the State must invest in research to provide scientifically supportable policies regulations, and methods.

I have identified 9 high priority research topics which the D.E.P. has recognized as necessary to the long term attainment of its mission. These topics meet the goals established in the November 4th meeting and are compatible with the 13 points of Senator George Mitchell's Marine Research Bill (in parentheses at the end of each topic). They are also projects which are beyond the capabilities of the D.E.P. and therefore appropriate topics for consideration by the Commission as priority research.

. Pollutant transfer and transport Abundance of a chemical in water or sediments does not necessarily indicate an environmental problem. The key question is whether or not these chemicals are entering the food chain, whether they are bio-concentrating in tissues or castings, and what the breakdown rates and products are. Criteria exist for freshwater yet none exist for sediments. The information is critical to safely licensing discharges as well as assessing the threat posed by unlicensed activities. (#6)

. Tissue chemistry - At the organism level, there exists very little information to indicate the effect of different chemicals in tissues on physiology. Reproduction, growth, and behavior effects are not well understood. Not only is this information directly useful to resource managers, it is useful to environmental regulators needing to determine impacts associated with activities producing those chemicals.(#3)

. Sub-lethal toxic effects - While much information exists on acute toxicity of various chemicals, little is known of their chronic and sublethal effects. Growth, reproduction, and behavior are but some of the physiological concerns. For example, some fishery biologists are suggesting an avoidance response by fish to the presence of chlorine at levels below analytical detection thus blocking passage of fish up tidal rivers. At what concentration does chlorine become a problem? What season? This is a perfect example of balancing public health with commercial resources, yet to do so requires research to determine the exact levels necessary to properly manage both.(#3)

. Eutrophication - As the population of coastal Maine grows, the volume of domestic waste discharged to our coastal waters increases. We acknowledge that the assimilative capacity of our coastal waters is finite before adverse changes occur yet we do not know the incipient loading levels, the changes to expect, or the contribution of the many environmental variables specific to each receiving water. Much need to be done to develop predictive models for development of waste load allocations.(#3,6)

. Biological indicators - The newly revised Water Classification Program emphasizes biological community standards. The D.E.P. has developed standards for freshwaters which can be used to assess classification attainment. A parallel system must be developed for the marine and estuarine environment. Biological systems are widely used as indicators of environmental quality. They are particularly useful in determining whether or not certain activities are causing an ecologically significant problem. Development of marine biological standards is a crucial component to monitoring the effectiveness of environmental protection.(#1,2,3,4,5,6,7,8,9)

. Methods development - Efficient tools, especially interpretive techniques, for environmental assessment are lacking. Present methods are time consuming often resulting in missed opportunities, poor management decisions, and the potential for serious environmental and/or economic consequences. Basic questions such as "where in the marine environment are specific pollutants most likely to be found? Fine sediments, tissues, water, sub-tidal, intertidal, what salinity?" "What organs are most likely to accumulate specific chemicals?" What experimental sampling designs are most efficient and under what circumstances?" What is the statistical reliability of their results?" Investigations such as these would add immeasurably to the value of monitoring data and are suited to division into small graduate level projects.(#9,13)

. Habitat Valuation - If the Department is to "direct growth and development to preserve for all time an ecologically sound and aesthetically pleasing environment", there needs to be an objective means determining direction. Knowing which salt marshes, tidal flats, estuaries etc. are more important that others and why is key to properly directing development.(#2,4,7)

. Public Health - Two areas of contamination stand out regarding public health, neither of which necessarily constitute and ecological problem. Exposure of people to pathogenic bacteria and viruses through water contact recreation or shellfish consumption is fairly well understood and managed and does not threaten environmental integrity. Exposure of people to toxic or carcinogenic chemicals in food items, however, is less understood and risk not well established. Recommended acceptable daily intake levels have been established for only a handful of chemicals. Human health risk management suffers as a consequence.(#10)

. Hydrodynamic modelling - Effects of fresh water, sediment, and pollutant inputs are strongly influenced by coastal currents, upwelling, tides and mixing. In order to accomplish many of the preceeding goals, a thorough understanding of coastal hydrodynamics is imperative.(2,8)

While the D.E.P. is capable of monitoring ambient conditions, it suffers from a lack of information enabling it to put monitoring information into an ecological and human health perspective. Research into any of the above areas will enable the Department to manage wastewater, dredge spoils, urban runoff, sanitary wastes, aquaculture, snow dumps, landfills, and the many other activities under its charge, in a responsible manner.

BOWDOIN COLLEGE

MARINE RESEARCH LABORATORY BRUNSWICK, MAINE 04011

16 November 1988

Ms. Gro Flatebo
Office of Policy and Legal Analysis
State House Station 13
Augusta, Maine 04333

Dear Gro,

Thank you for your letter of 7 November. Because of a family commitment I will not be able to attend the meeting on 21 November. I am enclosing some comments on the 25 October draft report to the Coles Commission.

My colleagues and I at Bowdoin believe that there is a problem with the priorities set in the draft report. Of 19 priority items identified in the draft report, only 6 deal with estuaries and the nearshore environment. At the present time the estuaries and nearshore waters of the Gulf of Maine are under acute development pressure. State decision makers need information on the ability of these systems to withstand human induced impact.

We believe that there are three general areas of nearshore investigation that must be addressed as quickly as possible.

I. How can we define what is a 'normal' or 'expected' state of a natural environment, i.e. how can we best detect changes in environmental conditions that are outside those normally observed. Given that all natural environments are in a constant state of flux, this is a non-trivial problem. It is imperative to do this so that the state can determine what is an 'unreasonable' change as required by law. It is also imperative that we do this so that deleterious environmental changes can be identified early on and an appropriate response can occur.

II. In order to prevent dilution of effort in regulation and control it is necessary to develop methods to identify those human caused changes in the environment that are actually associated with observed ecological changes. What is required is a way to relate observed concentrations of pollutants to observed ecological effects. To be able to determine which of the several pollutants present in an environment are actually associated with deleterious ecological effects will provide valuable input to long-range planners. We

believe that this is an attainable goal for many species living in the Gulf of Maine.

III. We must determine the degree to which non-point sources of pollution, particularly nitrogen and phosphorous, are causing adverse changes in the coastal environment. It is virtually certain that the shellfish kill in Maquoit Bay last September was a result of excessive nutrient loading.

My colleagues and I at Bowdoin are primarily interested in looking at responses of marine animals and plants to the consequences of human activity. We have been developing a suite of stress responses in marine animals and plants. We have been working in the estuaries and very near shore waters because we believe that it in these areas that pollution effects appear first. We also believe that the Gulf of Maine is an excellent natural laboratory in which to study pollutant effects because relatively clean reference areas are more numerous than polluted areas. Because the same types of pollutants cause problems elsewhere, lessons learned here can be transferred to other locations.

We have been particularly interested in responses of marine animals and plants in multiple pollutant situations in the field. We believe that this is a very cost effective approach to assessing the environmental health of an area. Our approach has been to measure a number of stress responses in animals and at the same time determine body burdens of a variety of potential stressors such as heavy metals, petroleum compounds and synthetic organic compounds such as tributlytin. We have been using multivariate statistical techniques to successfully associate physiological responses with particular stressors. We believe that these techniques will allow those pollutants requiring immediate attention to be identified in field situations.

Goals I and II are currently being addressed at Bowdoin; we are beginning to address Goal III. Goals I and II speak to habitat assessment; Goal III speaks to resource management. I am enclosing a bibliography of 20 papers and 6 manuscript reports which represent work carried out by my colleagues and myself on Maine plants and animals.

My colleagues and I do not believe that inshore, applied marine research should be carried out in place of offshore, more basic, marine research. These types of research should be carried out in parallel. It is clear that research in both areas will yield valuable information that is not now being generated.

If you would like any further information, please do not hesitate to get in touch with me.

Best regards,

Ed

Edward Gilfillan
Director

APPENDIX C

CURRENT RESEARCH BY MAINE INSTITUTIONS

APPENDIX C: CURRENT RESEARCH FOCUS BY INSTITUTIONS

This section outlines some of the agencies and institutions in this state that conduct research in or about the Gulf of Maine. While the list is not complete, it does reflect the diversity of groups involved in research. This section is broken down by sector: state agencies, academic institutions and private research institutions. Much of the text is borrowed from a memo by Dr. David Townsend to the Coles Commission on Marine Research (11/2/88), individual submissions to the commission and from "Coastlinks" a publication of Maine's Coastal Program.

1. STATE AGENCIES

A. Maine Department of Marine Resources

The Department of Marine Resources (DMR) is "the primary state agency engaging in research for the conservation of marine resources". The Bureau of Maine Sciences within DMR has underway research and monitoring programs in five categories: pelagic fisheries, benthic and demersal fisheries, lobster fisheries, fisheries and health and research services. The primary thrust of their research activities are both to develop and conserve the marine resources of Maine, giving the Department an applied science approach to marine research.

Funding for DMR's activities in FY1988 totalled $1.9 million of which 72% came form the general fund, 22% from federal sources and 6% from other sources. More than one-third of the scientific staff and two-thirds of the support staff in the Bureau are funded by the federal government. Two maintenance position also are federally funded. Last year, three scientific positions were cut.

B. Maine Geological Survey

The Maine Geological Survey (MGS) is mandated to gather, analyze, interpret, publish, and disseminate information relating to geological features of the State. Marine-related activities of the MGS are focused on the geologic and human response to sea-level rise; sediment budgets and the pathways, rates and mechanisms of sediment transport in the inshore area including dredging and spoils disposal; sediment accumulation and erosion in salt marshes and tidal flats and the evaluation of the mineral potential of Maine's coastal zone.

Specific marine projects include mapping the sea floor and performing routine mineralogical studies, evaluating the role of eroding bluffs to the sediment budgets of several embayments, evaluating dredge spoils dumped in Saco Bay and mapping coastal hazards on sand beaches. Funding for marine related projects this past year was approximately $95,000 from federal sources and $25,000 from state sources as state match.

C. Maine Department of Environmental Protection

The Department of Environmental Protection (DEP) is just beginning a marine monitoring program in 1988 to assess pollution in Maine's nearshore waters. The program is presently limited in scope and is characterizing four coastal areas (Boothbay Harbor, Machias Bay, Casco Bay and the Piscataqua River estuary) for the occurrence of heavy metals, PCB's, PAH's and selected organic compounds in soft sediments and their availability through the water column to blue mussels and the associated benthic community structure. Funding in FY89 includes $33,500 from the State and $31,000 from the coastal program.

D. Maine State Planning Office

The Maine Coastal Program of the State Planning Office receives federal monies from the Office of Coastal Resource Management, in NOAA. These monies are used to support planning and enforcement in coastal areas in Maine. In addition, approximately $350,000 is available to address issues and concerns in the coastal area. In the past, these funds have addressed predominantly land-based concerns although approximately $30,000 has been available for marine research annually. This program also has funded mapping projects within the MGS.

Currently, the SPO has received a grant from OCRM for $80,000 to strengthen and facilitate the interstate management of the Gulf of Maine's coastal and marine resources. The project will outline a methodology for environmental monitoring of the Gulf and produce a report on the state of the Gulf. The project seeks to strengthen institutional relationships between the states and provinces bordering the Gulf in order to facilitate bilateral management efforts.

E. Maine Department of Inland Fisheries and Wildlife

The Department presently conducts studies to determine the life requisites and status of various forms of marine wildlife, the location of sensitive or otherwise significant wildlife habitats, and habitat protection standards. The most recent work has been funded with Coastal Zone Management monies.

2. Academic Institutions

A. University of Maine

The University of Maine engages in a wide range of marine research, both basic and applied, reflecting the interests and expertise of faculty in various departments such as botany and plant pathology, microbiology, zoology, geology, civil engineering, physics, economics, and animal and veterinary sciences. The University's marine faculty and programs are coordinated under an umbrella organization known as the Center for Marine Studies.

Much of the marine research conducted at the University is funded by the federal government through the University of Maine/University of New Hampshire Sea Grant College Program. Sea Grant-funded research is directed at promoting the wise use, conservation, and management of the nation's marine and Great Lakes resources. Two major areas of Sea Grant research at the University include fisheries management and development and changes in the coastal environment. Sea Grant has approximately $400,000 available for grants annually.

Research at the University is also conducted and funded under the Maine Agricultural Experiment Station's Fisheries and Agriculture Group, as well as through the Maine Lobster Institute and the Ira C. Darling Center, which are part of the Center for Marine Studies. Funding for marine research at the University included $1,260,000 in direct costs in FY87, and $2,030,000 in indirect costs which includes basic infrastructural support, salaries for faculty, staff and administrative support.

B. Bowdoin College

The Marine Research Laboratory and Hydrocarbon Research Center at Bowdoin College conducts research on responses of marine animals and plants to human activity, in particular, the physiological responses of marine organisms to multiple pollutant situations. Funding at present comes primarily from the Mobil Foundation and college funds; this year's funding level is approximately $30,000.

C. Shoals Marine Laboratory- Cornell University

The Shoals Marine Laboratory, supported by Cornell University, is geared to educating undergraduates in marine sciences. Ongoing research activities include projects on cormorant colony dynamics and sea urchin/codium interactions.

D. The Marine Law Institute

The Marine Law Institute at the University of Southern Maine, conducts research and educational projects on legal and public policy issues concerning the marine environment. The Institute publishes a quarterly report entitled Territorial Sea as well as books and reports on specific topics. The efforts of MLI have focused on 1) management of the Gulf of Maine in light of the recent international maritime boundary dispute with Canada, 2) legal principles affecting the coordination of state and federal fisheries laws and policies, and 3) the use of science in marine resource regulation.

E. Maine Maritime Academy

Maine Maritime Academy offers a variety of marine oriented undergraduate and masters degree programs and is presently planning to offer a 4 year undergraduate program in marine science. While the Academy has not engaged in marine research itself, it does provide support by making its expertise and facilities available to the marine research community. The latest effort on behalf of the Academy is acting as the ship operator for the R/V Argo.

Undergraduate students in the new Ocean Studies program at the Academy will be required to participate in cooperative research experience aboard the R/V Argo and in shore based research labs. A viable Gulf of Maine research program will benefit the academic program at the Academy and the student participation will provide valuable assistance in conducting research on the Gulf of Maine.

3. Private Research Institutions

A. Bigelow Laboratory for Ocean Sciences

Marine research at the Bigelow Laboratory for Ocean Sciences is funded by grants and contracts which totalled $2,200,000 in FY87. The State of Maine provided $100,000 in direct infrastructural support; private funding at the Lab is approximately $40,000 per year. The remainder of the Laboratory's budget is met by individual research grants and contracts from federal agencies such as NSF, NASA, NOAA, and ONR.

Approximately one third to one half of the Laboratory's research concerns the Gulf of Maine; these are primarily "basic" research programs funded by grants awarded directly to the Principal Investigators. The research areas include studies of larval herring, benthic invertebrate populations, mid-water particle maximum layers, sediment geochemistry, phytoplankton and zooplankton dynamics, nutrient dynamics and physical oceanographic studies.

B. Mount Desert Island Biological Laboratory

Marine research activities at the MDIBL center about the comparative physiology of marine organisms from Frenchman Bay and the Gulf of Maine. Research is generally focused on organ actions, epithelia-cell membrane transport, and developmental biology. Approximately 50 scientists engage in research at the Laboratory at some time during the year, though as many as 150 may be present during the summer peak. The Laboratory's total budget for FY88 is approximately $675,000, coming almost entirely from federal sources, with the exception of $50,000, which comes from a private trust.

C. West Quoddy Biological Research Station

The goals of the West Quoddy Biological Research Station are to promote resesarch, education and wildlife rehabilitation of the West Quoddy/ Bay of Fundy region. Current programs include studies on indigenous and migratory species with emphasis on marine mammals and rescue and rehabilitation of injured or orphaned marine wildlife.

D. Association for Research in the Gulf of Maine (ARGO - Maine)

ARGO Maine is a consortium of academic, private and governmental organizations dedicated to promoting and coordinating marine research on the Gulf of Maine. The impetus behind the development of ARGO Maine was to stimulate a fisheries oceanography program focusing on basic oceanography. The group has evolved to include a perspective of coastal impacts on the marine ecosystem. ARGO Maine is comprised of the Bigelow Laboratory for Ocean Sciences, the Department of Marine Resources, the Maine Geologic Survey, the Maine Maritime Academy and the University of Maine. ARGO Maine supports an 80-foot research vessel and holds periodic conferences.