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Woods Hole Oceanographic Institution

WOODS HOLE OCEANOGRAPHIC INSTITUTION
1930

THE ADMINISTRATIVE POLICY PROCESS FOR SCIENCE: A CASE STUDY OF ORGANIZATIONAL-ENVIRONMENTAL DYNAMICS

by

Peter Francis Hooper

August 1979

TECHNICAL REPORT

Prepared with funds from the Pew Memorial Trust and for the Department of Commerce, NOAA Office of Sea Grant under Grant 04-8-M01-149, and the Institution's Marine Policy and Ocean Management Program.

WOODS HOLE, MASSACHUSETTS 02543

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Approved for Distribution ______________________
Dr. Robert W. Morse

THE ADMINISTRATIVE POLICY PROCESS FOR SCIENCE:
A CASE STUDY OF ORGANIZATIONAL-ENVIRONMENTAL DYNAMICS

Peter Francis Hooper

B.A., St. Michael's College, 1971
M.P.A., Northeastern University, 1973

A Dissertation

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Doctor of Philosophy

at

The University of Connecticut

1979

PREFACE

This study of marine science policy is the product of more than two years of investigation into the policy process of the International Decade of Ocean Exploration (IDOE), a marine science program of the National Science Foundation. The study had its beginnings in a broader investigation of the nature of the relationship between the marine science community and the network of Federal marine science funding agencies; a study conducted by Professors W. Wayne Shannon, David P. Palmer, and Everett C. Ladd, Jr., all of the University of Connecticut.

For more than a year I worked as a graduate assistant and later as a research associate for the University of Connecticut study. The experience greatly increased my knowledge of the marine science-government system in the United States. My own work was also initiated at that time, supported in part with funds from the University of Connecticut Research Foundation. Most recently I have held a research position in the Marine Policy and Ocean Management Program at the Woods Hole Oceanographic Institution to complete my own work on the IDOE policy process[a]. Many of the

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[a]The Marine Policy and Ocean Management Program at the Woods Hole Oceanographic Institution is supported with funds from

scientists at the "Oceanographic" have participated in IDOE funded science projects and have openly discussed with me their work and their attitudes toward IDOE program administration. Their valuable insights and perspectives were weighted against my own experiences and biases as an outsider, a social scientist, and a student of government and politics.

I am particularly grateful to the numerous scientists and administrators involved with IDOE who were willing to answer questions and explain points of science that must have seemed quite elementary to them. At the Woods Hole Oceanographic Institution, Dr. K. O. Emery, Dr. George Grice, Dr. Derek Spencer and Dr. H. Burr Steinbach, all listened, answered, and otherwise attempted to "set me straight on a few things".

I also have special appreciation for the IDOE staff, past and present, including Dr. J. L. McHugh, Mr. Feenan Jennings, Dr. Lauriston King, Dr. Bruce Malfait, Dr. Worth Nowlin, and all the program managers and assistant program managers who donated valuable time to improve my understanding of science administration.

The Founding Father of IDOE, Dr. Edward Wenk, Jr., former Executive Secretary of the Council on Marine Resources, Engineering and Development and now Director of the

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the Pew Memorial Trust and the Department of Commerce, Office of Sea Grant under grant #04-8-M01-149.

Program in the Social Management of Technology of the University of Washington, opened up his files to my research and made my task immensely easier. He is to be thanked most highly. I am grateful, as well, to Dr. Warren Wooster, principal author of An Oceanic Quest which charted the scientific course for IDOE, and, more recently, The Continuing Quest which is an attempt to define the next step in large scale oceanographic research. Dr. Wooster kindly submitted to three separate interviews.

I also wish to thank my colleagues in the Marine Policy and Ocean Management Program, particularly Dr. James R. McGoodwin who listened endlessly to my dissertation blues and wisely counseled me on all manner of concerns. Mrs. Ann Martin expertly edited the manuscript, although I was continually revising sections, so she cannot be held accountable for any clumsy grammar that may have never reached her sharp eye. Mrs. Lynda Davis, Miss Kaleroy Hatzikon, and Mrs. Ann Goodwin all graciously typed sections of early drafts and Mrs. Jane Zentz typed the final manuscript. They all deserve my earnest appreciation.

At the University of Connecticut Professors Ladd and Shannon provided direction to my graduate training and included me on their research team in the marine science policy investigation. Harold Seidman and his work in the area of the politics of organization provided much of the intellectual stimulation for the study. I am further grateful to Professors Ladd, Shannon, and Howard Reiter for serving on my dissertation committee and carefully guiding me through the exercise.

My heaviest debt is owed to my wife, Peggy, and our children Jeffrey and Gretchen, who sacrificed a great deal for distant, but hopeful, rewards.

TABLE OF CONTENTS

PREFACE..

LIST OF TABLES... x

LIST OF FIGURES.. xi

ABSTRACT...xiii

INTRODUCTION... 1

Chapter

I. MARINE SCIENCE GROWTH IN THE UNITED STATES, 1950-1979.. 10

INTRODUCTION.................................... 10
MANPOWER.. 12
EXPENDITURES.................................... 15
LARGE SCALE OCEANOGRAPHIC RESEARCH.............. 21

II. ORGANIZATIONAL DEVELOPMENT: PRE-ORGANIZATIONAL POLICY INFLUENCES.................................... 29

INTRODUCTION.................................... 29
THE COUNCIL..................................... 30
THE SCIENTISTS.................................. 47
THE INTERNATIONAL CONTEXT....................... 53
THE FOUNDATION.................................. 56
ANALYSIS.. 60

Government Channels of Development............ 60
Support....................................... 67
Organizational Location....................... 70

III. PROGRAM INITIATION: ORGANIZATIONAL, ADMIN-ISTRATIVE, AND CLIENTELE POLICY INFLUENCES........ 74

INTRODUCTION.................................... 74
CONTINUED PLANNING.............................. 74

ORGANIZATION.. 79

International Decade of Ocean Exploration.. 79
National Science Founcation.................... 84
Funding.. 89

ADMINISTRATIVE ARRANGEMENTS.................... 93

Goals.. 93
Program Emphasis.............................. 96
Preparation of Proposals...................... 99
Guidelines for Evaluation..................... 100
Evaluation Procedures......................... 101
Administration................................ 103

THE "TYPICAL" NSF SYSTEM IN CONTRAST............ 104
CLIENTELE INFLUENCES............................ 106

Political Activity............................ 106
National Academy of Sciences.................. 108
IDOE Funding Recipients and All Others........ 111

ANALYSIS.. 117

IV. PROGRAM IMPLEMENTATION........................ 125

INTRODUCTION.................................... 125
GEOSECS... 126
CEPEX... 135
CLIMAP.. 142
MODE/POLYMODE................................... 146
EASTERN ATLANTIC CONTINENTAL MARGIN STUDY........ 156
MANGANESE NODULES PROJECT/MANOP.................. 160
ANALYSIS.. 170

International Theme........................... 171
Directed Scientific Research on Long-term Practical Problems............................ 174
Large Scale................................... 176

V. PROGRAM EVALUATION AND INSTITUTIONALIZATION....... 181

INTRODUCTION.................................... 181
IDOE GOALS...................................... 182
EVALUATING IDOE................................. 185

NAS-NAE....................................... 185
NACOA... 190

NSF.. 194
Harbridge House Inc.......................... 195

INSTITUTIONALIZING IDOE...................... 201

NACOA.. 201
NAS-NAE...................................... 202
NSF Response................................. 206

CONCLUSION................................... 208

APPENDIX 1................................... 212

APPENDIX 2................................... 214

APPENDIX 3................................... 216

SOURCES CONSULTED............................ 218

LIST OF TABLES

1. ASSESSMENT OF ACADEMIC EMPLOYMENT OPPORTUNITIES FOR NEW PH.D.'S BY FIELD OVER THE NEXT FIVE YEARS....... 16

2. IDOE STAFF PREVIOUS WORK EXPERIENCE BY SECTOR....... 81

3. NUMBER OF FEDERAL FUNDING SOURCES BY IDOE FUNDEES AND ALL OTHERS.............................. 112

4. TYPE OF RESEARCH BY IDOE FUNDEES AND ALL OTHERS..... 113

5. APPLICATION OF INCREASED FEDERAL FUNDING TO OCEANOGRAPHIC NEEDS BY IDOE FUNDEES AND ALL OTHERS.. 116

6. RANK ORDERING OF AREAS OF RECOMMENDED INCREASED FEDERAL FINANCIAL SUPPORT........................ 122

7. IDOE-GEOSECS EXPENDITURES FY 1971-1977.............. 129

8. IDOE-CEPEX EXPENDITURES............................. 136

9. IDOE-CLIMAP EXPENDITURES FY 1971-1977............... 143

10. IDOE-MODE EXPENDITURES.............................. 152

11. IDOE-POLYMODE EXPENDITURES.......................... 156

12. IDOE EASTERN CONTINENTAL MARGIN STUDY EXPENDITURES...................................... 158

13. IDOE-MANGANESE MODULES/MANOP EXPENDITURES FY 1972-1977... 162

14. PARTICIPATION BY OTHER NATIONS IN U.S.-LED IDOE PROGRAMS...................................... 173

15. HARBRIDGE HOUSE EVALUATION OF USEFULNESS OF IDOE PROJECTS...................................... 177

16. HARBRIDGE HOUSE SUMMARY EVALUATIONS OF SIX SELECTED IDOE PROJECTS............................. 200

17. ESTIMATED COSTS OF POST-IDOE PROGRAM................ 204

LIST OF FIGURES

1. INCREASES IN NATIONAL SCIENTIFIC OCEANOGRAPHIC PERSONNEL, SELECTED YEARS, 1950-1977................ 13

2. INCREASE IN NATIONAL MARINE SCIENCE PROGRAM AS A PROPORTION OF ALL U.S. R & D EXPENDITURES, 1953-1976.. 18

3. CUMULATIVE PERCENT INCREASE/DECREASE IN NATIONAL MARINE SCIENCE BUDGET AND TOTAL U.S. R & D EXPENDITURES, IN CURRENT AND CONSTANT DOLLARS, 1966-1976.. 20

4. CUMULATIVE PERCENT INCREASE/DECREASE IN THE TOTAL MARINE SCIENCE BUDGET AND THE OCEANOGRAPHIC RESEARCH BUDGET, CURRENT AND CONSTANT DOLLARS, 1966-1976........................... 22

5. PERCENT OF SCIENCE PAPERS PUBLISHED BY ONE, TWO, OR THREE OR MORE AUTHORS, SELECTED YEARS 1921-1977.. 24

6. PROPOSED INTERIM ORGANIZATION FOR PLANNING U.S. PARTICIPATION IN AN INTERNATIONAL DECADE OF OCEAN EXPLORATION.................................... 39

7. IDOE ORGANIZATIONAL STRUCTURE......................... 83

8. NSF ORGANIZATIONAL STRUCTURE, SELECTED PROGRAMS, 1971...................................... 85

9. NSF ORGANIZATIONAL STRUCTURE, SELECTED PROGRAMS, 1975...................................... 87

10. ORGANIZATIONAL STRUCTURE OF THE DIRECTORATE FOR ASTRONOMICAL, ATMOSPHERIC, EARTH, AND OCEAN SCIENCES, SELECTED PROGRAMS, 1975.............. 88

11. ACTUAL IDOE PROGRAM OFFICE FUNDING AWARDS 1971-1977.. 90

12. CUMULATIVE PERCENT INCREASE/DECREASE IN COMPONENTS OF THE FEDERAL MARINE SCIENCE PROGRAM, 1971-1977.................................. 94

13. GEOSECS ORGANIZATIONAL STRUCTURE..................... 132

14. CEPEX ORGANIZATIONAL STRUCTURE....................... 140

15. CLIMAP ORGANIZATIONAL STRUCTURE...................... 145

16. MODE ORGANIZATIONAL STRUCTURE........................ 150

17. POLYMODE ORGANIZATIONAL STRUCTURE.................... 155

18. MANOP ORGANIZATIONAL STRUCTURE....................... 167

THE ADMINISTRATIVE POLICY PROCESS FOR SCIENCE: A CASE STUDY OF ORGANIZATIONAL-ENVIRONMENTAL DYNAMICS

Peter Francis Hooper, Ph.D.

The University of Connecticut

The research is a case study of the policy process for a federal agency that supports large scale basic scientific investigations. The agency studied is the Office for the International Decade of Ocean Exploration (IDOE) in the National Science Foundation (NSF). The IDOE is a ten year program (1971 to 1980) for the support projects that, it is expected, will lead to more enlightened preservation of the ocean environment, improved environmental forecasting, and better management of marine mineral exploitation.

The study adopts an institutional approach, focusing on the organizational and clientele factors that shaped the program's development and implementation. The principal finding is that although originally undertaken as a major innovative science-non-science enterprise with political, economic, and scientific implications, the IDOE was transformed and scaled-down into one more consonant with the routinized expectations of the marine science community, and assimilated into the typical NSF mode of operation.

Peter Francis Hooper--The University of Connecticut, 1979

The pre-organizational channels of program development are described and analyzed, as are the program's early support groups, organizational structural factors, administrative arrangements, and clientele considerations. In addition, six of the twenty projects supported by IDOE funds are examined in depth. Collectively, the six projects demonstrate the breadth of scientific and managerial expertise brought to bear on programmatic concerns.

Data collected through a mail survey conducted in 1977 from a sample of 800 marine scientists in the United States are utilized to compare and contrast IDOE supported scientists and other marine scientists. Personal semi-structured interviews with approximately forty administrators, scientists, and interested observers of IDOE are also employed.

The research represents a contribution to the study of interest group-organizational dynamics. Too few investigators have focused their attention on this micropolitical process. The science-government relationship is a particularly important one in our technoscience age and it promises to become even more critical in the years to come.

INTRODUCTION

The following study attempts to trace the development of a Federal program of science support -- the International Decade of Ocean Exploration (IDOE) -- from its conception in 1966 to its near conclusion more than ten years later. The research adopts an institutional approach, focusing on the organizational and clientele factors that shaped the program's development and implementation. In particular, the study examines the channels of government through which the program idea was shaped, its early support groups, its location in the federal bureaucracy, its mode of operation or administrative arrangements, and its clientele relationship.

Social scientists approach the study of public policy from many perspectives, including: systems theory, elite theory, group theory, rational decision-making theory, incrementalism, game theory, and institutionalism among others (Dye, 1978:19). The approach adopted here is most accurately described as institutional.

The institutional approach was dominant in political science at the turn of the century. At that time its chief concerns were with institutional structure, organization, and constitutional duties and functions (Somit and Tanenhaus, 1967:ch 2; Ziegler, 1964:2-6). The institutions for making and carrying out the laws were studied as if they existed in a sphere isolated from man's control or influence. No effort was made to study whether outside interests or institutional factors themselves helped shape or determine policy contents. Modern social scientists carry the institutional approach further to make the important linkages between structure and policy (Allison and Szanton, 1976; Lambright, 1976; Seidman, 1975). As described by Thomas Dye:

> (i)nstitutions may be so structured as to facilitate certain policy outcomes and to obstruct other policy outcomes. They may give advantage to certain interests in society and withhold advantage from other interests. Certain individuals and groups may enjoy greater access to government power under one set of structural characteristics than under another set. In short, the structure of governmental institutions may have important policy consequences (1978:21).

The institutional approach is adopted here because of the unique R & D institutional framework and pattern of relationships between scientists and their federal sponsors in the United States, and the consequences of this system for the conduct of science.

Until World War II the Federal government had rejected as unconstitutional any responsibility for the support of scientific research, except when it advanced the smooth flow of commerce or industrial growth (Dupree, 1945). During the War, the constitutional arguments were forgotten and great sums of money were poured into the expeditious development of military hardware and technologies. The Federal government continued to support military research after the War, and it soon assumed a role as a major supporter of almost all types of scientific research. Between 1945 and the early 1960's the science-government complex grew in spectacular, if haphazard leaps and bounds, in response to an assortment of particular needs (Penick et al., 1972). By the late 1960's a broad array of governmental and private sector institutional arrangements had been developed for the conduct of different types of research and development.

> In-house Government Laboratories: maximum responsiveness and an advantage in carrying out R & D work "which directly supports the management functions of the agency"
>
> Colleges and Universities: an intellectual environment "highly conducive to successful undirected and creative research by highly skilled specialists," not amenable to "management control by adherence to firm schedules, well defined objectives, or predetermined methods of work"
>
> University-associated Research Centers: suited to basic or applied research "for which the facilities are so large and expensive that the research acquires the character of a major program best carried out in an entity apart from the regular academic organization"
>
> Not-for-profit Organizations: independence from government and from the commercial market, "which may make them particularly useful as a source of objective analytical advice and technical services"
>
> Contractor-operated Government Facilities: government gets the advantages of retaining direct federal control while also enjoying the advan-

tages of staffing and management flexibility more inherent in industry and the university

<u>Profit Sector</u>: special advantages when "large and complex arrays of resources needed for advanced development and pre-production work must be marshalled quickly" (Teich and Lambright in Haberer ed., 1977:169; adapted from U.S. Congress, Senate, 1962).

Each institutional arrangement developed an identifiable mode of operation, organizational culture, and clientele, that reinforced its specialized role. The organizations that were initiated to support the development of war technologies established a unique relationship with the armaments industry and specialized modes of operation that facilitated arms production. The federal organizations at the other extreme, those that were established for the support of basic research, evolved a different but equally particularized connection with their funding recipients. Between the two, numerous institutional arrangements were made for the support and conduct of R & D.

The nature of the science support system in the United States closely resembles what Theodore Lowi has described as typical of the distributive policy arena.

These (distributive)policies are policies that are virtually not policies at all but are highly individualized decisions that only by accumulation can be called a policy. They are policies in which the indulged and

> the deprived, the loser and the recipient, need never come into direct confrontation. Indeed, in many instances of distributive policy, the deprived cannot as a class be identified, because the most influential among them can be accommodated by further disaggregation of the stakes (Lowi, 1964: 690).

Lowi identified several policy areas that fall into the distributive category including: public land and resource policies, rivers and harbors ("pork barrel") programs, defense procurement and R & D, labor policies, business policies, agricultural policies, and the traditional tariff (1964:690). It is not clear whether all of these policy areas are still distributive. Some are probably not, particularly in the cases of public land and resource policies which have recently been subjects of vigorous debates between environmental and business interests. Where the distributive policies remain, however, they are characterized by what E. E. Schattschneider has termed in his case study on tariffs as relationships of "mutual non-interference" -- "a mutuality under which it is proper for each to seek duties (indulgences) for himself but improper and unfair to oppose duties (indulgences) sought by others" (1935:135-136, taken from Lowi, 1964:693). The political relationship or subsystem is also characterized by low public visibility and a high level of stability among the participants. The primary locus of policy decisions for distributive policies is generally either the congressional committee or executive agency. In the case of scientific research the decisional locus is almost always the agency.

Lowi also identified two other policy arenas, regulatory and redistributive. Regulatory policies are similar to distributive in that they are specific and individual in their impact. They differ in that they involve "a direct choice as to who will be indulged and who deprived" (Lowi, 1964:690-691). In addition, although regulatory policies are dispensed case by case they "cannot be disaggregated to the level of the individual or the single firm, because individual decisions must be made by application of a general rule and therefore become interrelated within the broader standards of law" (Lowi, 1964:691).

The political relationship of regulatory policies is characterized by a high public visibility, competition among organized interests, and instability. The Congress in its classic role is considered the primary decisional locus. Regulatory policies include communications and most transportation policies, utilities policies, and energy programs.

Redistributive policies are similar to regulatory policies in the sense that "relations among broad categories of private individuals are involved, hence, individual decisions must be interrelated. But on all other counts there are great differences in the nature of impact. The categories of impact are much broader approaching social classes" (Lowi, 1964:691).

The redistributive political relationship is characterized by a high visibility, competition between broad sections of the population usually organized on a have-have-not basis or ideological basis, and stability. The executive generally serves as the decisional locus for redistributive policies. Medicare, the war on poverty, and aid to education are examples of redistributive policies (Ripley and Franklin, 1976 ch. 6).

Neither of these, regulatory or redistributive, adequately characterize the political relationship observed in the IDOE policy process.

In the case of IDOE we will focus on the agency itself, the primary decisional locus, and its clientele relationship in order to understand how policy is made. In addition, the pre-organizational government channels through which the program concept evolved and its early support groups are also observed for their impact on IDOE development (Boyer, 1964: Rourke, 1969; Seidman, 1975).

We will observe how IDOE was perceived by its originators as a major innovative science-non-science enterprise which cut across both the public and private sectors and had political, economic, and scientific implications. We will examine how the program was later reduced in scope and recast into a form with which the scientists could more easily identify, one that more closely approximated their understanding of the traditional (since 1945) science-government relationship.

We will then analyze how the program was implemented, devoting special attention to IDOE administration and its assimilation into the Foundation's standard operating procedures. The IDOE was established to support large scale basic investigations that have long-term social application while the Foundation is primarily a supporter of small scale undirected basic investigations.

The research will also examine the support for large scale science in general and IDOE in particular by the marine science community, and attempt to identify characteristics that distinguish IDOE funding recipients from other marine scientists.

Finally, the study will analyze the findings of several evaluations and reviews of IDOE; and consideration will be given to how the scientific strengths and weaknesses of the program, organizational factors, and clientele relationships, all contributed to a decision on the future of large scale marine science at the Foundation.

Most of the attitudinal information used throughout the study to determine perceptions of IDOE and its relation to the Foundation was collected through personal interviews conducted by the author with scientists, Federal officials, and other interested observers. The two principal interview schedules and list of interviewees appear in the appendices. The data used to compare and contrast IDOE funding recipients with other academic marine scientists along professional and demographic lines were obtained from a uniquely comprehensive survey of academic marine scientists conducted by a team of researchers at the University of Connecticut (Shannon et al., 1977).

Before proceeding to the IDOE case study, however, Chapter I attempts to introduce the subject of marine science, place it in perspective with regard to the total United States R & D effort, and make a critical distinction between two modes of scientific investigation,which is important for later aspects of the study.

CHAPTER I

MARINE SCIENCE GROWTH IN THE UNITED STATES, 1950-1979

INTRODUCTION

Marine science affairs is a term employed in the Marine Resources and Engineering Development Act of 1966, "to designate scientific research, engineering, and technological development related to the marine environment. The marine environment is considered to include the oceans, the Continental Shelf of the United States and its territories, the Great Lakes, and their resources" (Marine Sciences Council, 1967:13). The field involves a variety of participants, including local and state governments, the Federal government, universities, and chemical, electronics, aerospace, mineral, oil, fishing, recreational and other industries (marine sciences council, 1967:13-14).

Oceanography is the element of Marine Science Affairs that is broadly considered here. It is the basic and applied scientific element that involves a family of classical natural sciences applied to ocean phenomena. One of the most inclusive definitions of oceanography was given by the American oceanographer and first Director of the Woods Hole Oceanographic Institution, Henry Bigelow, in 1928.

> Oceanography...is the study of the world beneath the surface of the sea; it should include the contact zone between the sea and the atmosphere... It has to do with all the characteristics of the bottoms and margins of the sea, of the sea water, and of the inhabitants of the latter. It is thus widely inclusive, combining Geophysics, Geochemistry and Biology. Inclusiveness is, of course, characteristic of any "young" science, and modern Oceanography is in its youth. But in this case it is not so much youth that is responsible for the fact that these several sub-sciences are still grouped together, but rather the realization that the Physics and Chemistry and Biology of the sea water are not only important per se, but that in most of the basic problems of the sea all three of these subdivisions have a part. And with every advance in our knowledge of the sea making this interdependence more and more apparent, it is not likely that we shall soon see any general abandonment of this concept of oceanography as a mother science, the branches of which, though necessarily attacked by different disciplines, are intertwined too closely to be torn apart (Bigelow, 1929, taken from Schlee, 1973:12-13).

Oceanography has not changed fundamentally in the fifty intervening years. David Ross reemphasized the multidisciplinary nature of the field in his textbook on the subject, stating that "to truly understand the ocean and how it works, one must know something about almost all fields of science and their relationship to the marine environment. Thus, oceanography is not a single science, but rather a combination of various sciences" (Ross, 1977:4).

Chapter 1 attempts to illustrate the growth of oceanography from roughly 1950 to 1979, using two indicators -- manpower and expenditures -- and to introduce the notion of large scale science, and explain how it differs from the traditional small scale mode of inquiry.

MANPOWER

At the outset of World War II, oceanography in the United States was conducted primarily at three major research institutions -- the Scripps Institution of Oceanography, the Woods Hole Oceanographic Institution, and the Oceanographic Laboratories of the University of Washington -- and several other minor research laboratories. The Federal government also supported a small amount of oceanographic research, most of it "concentrated on work of immediate importance to navigation, principally surveying and charting of the sea bottom and measurements of the tides and currents in inshore waters" (NAS, 1952:35). It has been estimated that oceanography required roughly 30 to 60 scientists (Bigelow 1929:109).

The War and its aftermath resulted in vastly increased opportunities in oceanography because of the recognition of the importance of oceanographic information for military problems. In fact, the opportunities increased faster than the number of trained oceanographers. No reliable figures are available for the late 1940's, but in 1950 the number of oceanographers had increased to 200 to 250 individuals, according to the first International Directory of Oceanographers (Emery, 1950).

In the early 1950's the oceanographic community experienced a great influx of new personnel. A major study conducted by the National Academy of Sciences in 1958 estimated that there were slightly more than 400 oceanography-related

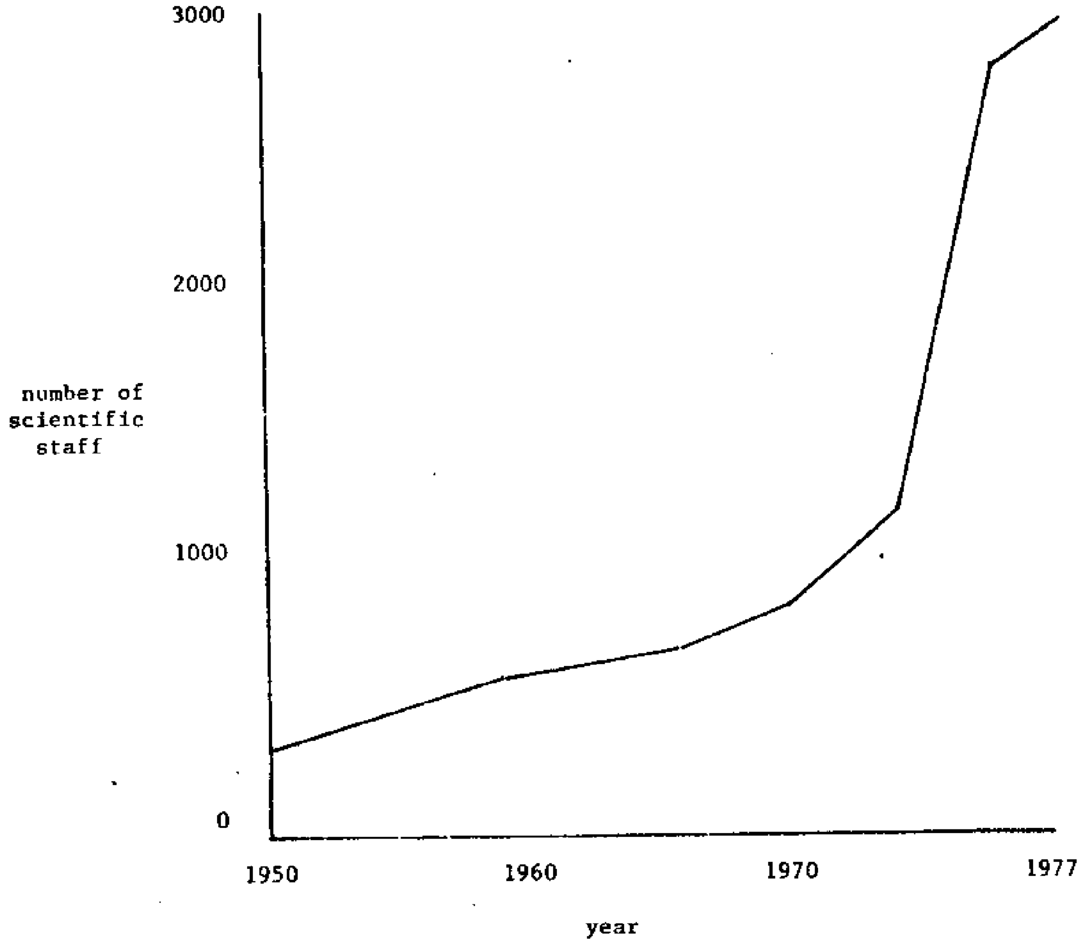

FIGURE 1. INCREASES IN NATIONAL SCIENTIFIC OCEANOGRAPHIC PERSONNEL, SELECTED YEARS, 1950–1977

Source: K. O. Emery, An International Directory of Oceanographers, Los Angeles, The Allan Hancock Foundation, 1950; and with Mary Sears, 1960; Richard C. Vetter, An International Directory of Oceanographers, Washington, D.C., National Academy of Sciences - National Research Council, 1964; and A Directory of Oceanographers in the United States, 1969; and a U.S. Directory of Marine Scientists 1975, 1975; Food and Agriculture Organization of the United Nations, International Directory of Marine Scientists, 1970; and 1977.

Ph.D.'s working in the United States. The third edition of An International Directory of Oceanographers published in 1960 included roughly the same number of individuals in the field (Emery and Sears, 1960).

By the mid-1960's the number of U.S. oceanographers had increased to approximately 550[a] (Vetter, 1964). Other more inclusive definitions of oceanographic personnel, including technical and engineering staff and M.S. degree holders, bloated the figures to 2,600 to 3,200 individuals (PSAC, 1966:71). Subsequent oceanographic personnel directories published in 1969, 1970, 1975, and 1977 included the names of approximately 750, 1250, 2900, and 3000 oceanographers respectively (Vetter, 1969; FAO, 1970; Vetter, 1975; FAO, 1977).

The expansion of the marine science community has apparently been a mixed blessing, because although it has contributed to the rapid intellectual advance of the field, the number of new positions has not kept pace with the number of new entrants. Survey findings of the University of Connecticut study indicate that academic oceanographers

---

[a]Whereas the first three directories published in 1950, 1955, and 1960 may have underestimated the size of the oceanographic community because of definitional limitations imposed by Emery, the 1964 directory and subsequent ones probably inflate the oceanography community's size somewhat.

now (1977) believe that employment opportunities for new Ph.D.'s are non-existent. A majority of oceanographers in all fields of research believe that there is an excess of oceanographers in the marketplace. Over three-quarters of the biologists believe there is an excess of personnel in their field, compared to roughly two-thirds in chemistry and geology and geophysics, and slightly more than half in physical oceanography.

EXPENDITURES

Many studies have been conducted since 1950 regarding the financial status of marine science in the United States. Different definitions applied to marine science and different study objectives, however, make it impossible to piece together a coherent, longitudinal perspective regarding financial growth.

In 1953 the National Oceanographic Program[a] was estimated at roughly $8 million (PSAC, 1966:67). By 1960 the Program had increased to $55 million. Throughout the 1950's the Program increased in absolute terms and also in relation to total U.S. expenditures for research and development (R&D). It expanded from roughly one-fifth of one percent of total

[a]The National Oceanographic Program was computed annually by the Interagency Committee on Oceanography from 1959 to 1966. It included most marine programs funded by the Federal government minus the government's defense components.

TABLE 1

ASSESSMENT OF ACADEMIC EMPLOYMENT OPPORTUNITIES FOR NEW PH.D.'S BY FIELD OVER THE NEXT FIVE YEARS[a]
(percent by column)

Employment Opportunities	Field[b]				
	Biology	Chemistry	Geology & Geophysics	Physical Oceanog.	Other[c]
More Positions than People to Fill Them	3.2	4.3	7.9	5.0	10.7
About the Same Number of Positions as People to Fill Them	14.2	24.3	22.9	28.6	20.8
An Excess of People	77.5	64.3	66.4	58.8	61.0
Don't Know	5.0	7.1	2.9	7.6	7.5
Number of Respondents	218	70	140	119	159

[a]"Looking ahead to the next five years how do you assess the employment opportunities in academic and non-academic organizations for new Ph.D.'s in your field?"

[b]Present primary field of research or scholarship

[c]Includes marine engineers, fisheries scientists, and marine related social scientists.

Source: W. Wayne Shannon, David D. Palmer, and Everett Carll Ladd, Jr., "The 1977 Survey of Academic Marine Scientists," conducted by the Social Science Data Center, the University of Connecticut, 1977.

U.S. R&D to one-half of one percent, still a very small proportion.

Publication in 1959 of Oceanography 1960-1970 by the National Academy of Sciences, Committee on Oceanography, acted to further stimulate growth, particularly for basic oceanographic research. By 1966 the National Oceanographic Program had grown to 207.6 million, fully 1 percent of all U.S. R&D expenditures.

In 1966 the newly established Marine Sciences Council replaced the National Oceanographic Program with the Total Federal Marine Science Program, which included all the elements of the National Oceanographic Program plus "certain classified naval programs; ships and vehicle research; additional technological developments related to such objects as fish, marine minerals, and energy resources; and seashore land use and recreation" (Marine Sciences Council, 1967:25). The redefinition of the national marine science effort represented a computational increase of 60.6 percent in 1966 and 79.0 percent in 1967 over projections of the National Oceanographic Program for those years (Marine Sciences Council, 1967:25-27).

From 1966 to 1977 the Total Federal Marine Science Program continued to grow throughout the eleven year period in terms of current dollars, although the funding increments were erratic from year to year. In 1972 constant dollars,

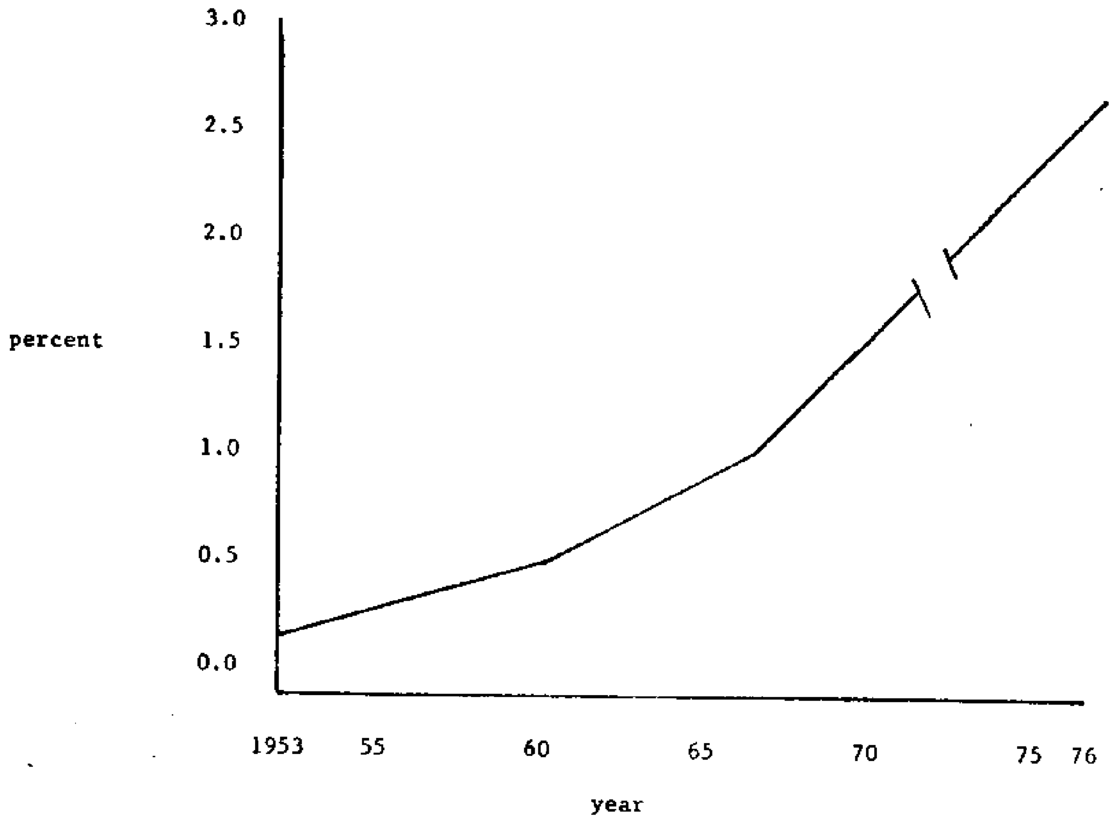

FIGURE 2. INCREASE IN NATIONAL MARINE SCIENCE PROGRAM AS A PROPORTION OF ALL U.S. R&D EXPENDITURES, 1953-1976

Source: President's Science Advisory Committee. Effective Use of the Sea, Washington, D.C., Government Printing Office, 1966; Interagency Committee on Oceanography, The National Oceanographic Program (Annual Report 1959 to 1966), Washington, D.C., Government Printing Office; Marine Sciences Council Marine Science Affairs (Annual Report 1967-1971), Washington, D.C., Government Printing Office; The Office of Science and Technology, The Federal Ocean Program, (Annual Report 1972-1974) Washington, D.C., Government Printing Office; Federal Council for Science and Technology, The Federal Ocean Program Budget Summary Fiscal Years 1975-1977, Washington, D.C., Government Printing Office (March 1976); National Science Foundation, National Patterns of R&D Resources: Funds and Personnel in the United States 1953-1978-79, Washington, D.C., Government Printing Office (NSF 78-313), 1978.

however, a very different picture emerges. Funding increased steadily until 1972, except for a small decline in 1968, but in 1973 and 1974, constant dollar funding levels declined to almost the 1971 level before leveling off in 1975 and 1976. This situation contrasts markedly with the one for total U.S. R&D which demonstrated practically no growth over the entire period. By 1976 the Federal marine science effort increased to 2.6 percent of total U.S. R&D expenditures.

The prosperity of the oceanographic research segment of the Federal marine science effort has varied enormously throughout the approximately 30 years under examination here. While it gained during the war years, it lagged in the late 1940's and for most of the 1950's. The Navy, the largest Federal supporter of oceanographic research until 1972, reported in 1959 that while it had doubled its overall R&D expenditures between 1947 and 1957, it "increased basic research expenditures by a factor of only 1.5. This smaller increase in basic research expenditures by the Navy was essentially offset by reason of the fact that total cost per scientist increased about 50 percent during this same period" (Naval Research Advisory Committee, 1959:59).

Publication of Oceanography 1960-1970 stimulated support for oceanography in Congress and resulted in increased budgets, which continued, except for 1967 and 1973, through

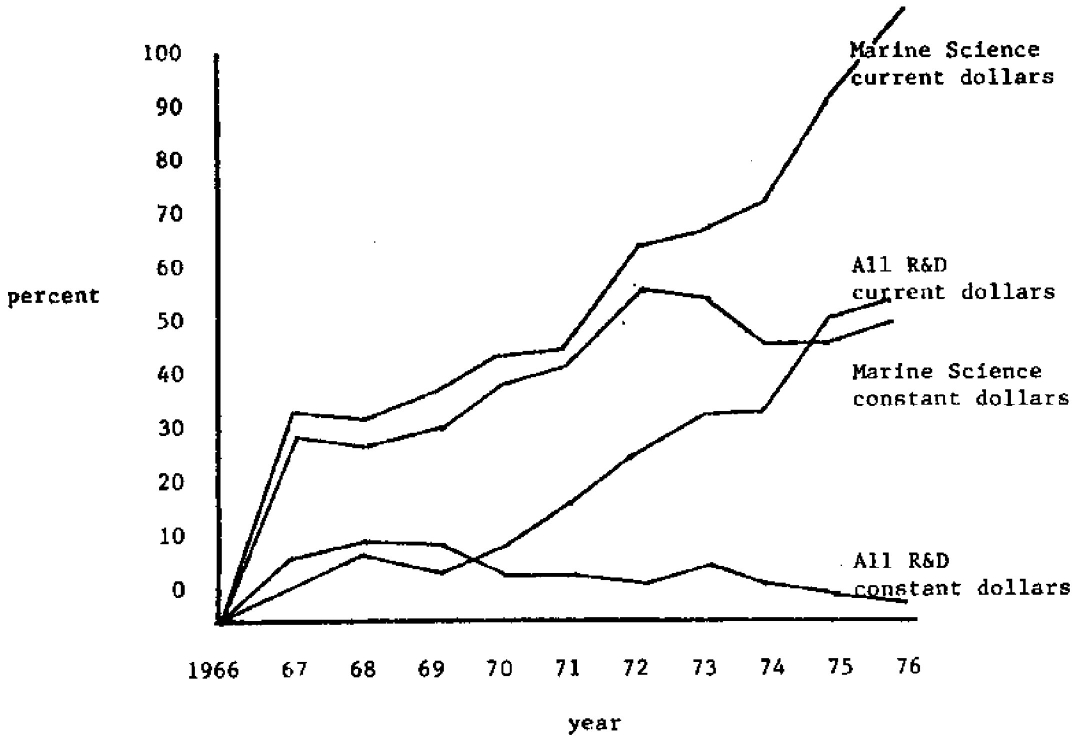

FIGURE 3. CUMULATIVE PERCENT INCREASE/DECREASE IN NATIONAL MARINE SCIENCE BUDGET AND TOTAL U.S. R&D EXPENDITURES, IN CURRENT AND CONSTANT DOLLARS, 1966-1976

Source: Marine Sciences Council, Marine Science Affairs (Annual Report 1967-1971), Washington, D.C., Government Printing Office; the Office of Science and Technology, The Federal Ocean Program, (Annual Report 1972-1974) Washington, D.C., Government Printing Office; Federal Council for Science and Technology, The Federal Ocean Program Budget Summary Fiscal Years 1975-1977, Washington, D.C., Government Printing Office (March 1976); National Science Foundation, National Patterns of R&D Resources: Funds and Personnel in the United States 1953-1978-79, Washington, D.C., Government Printing Office (NSF 78-313), 1978.

1977. Yet although budgets increased, they continued to decline as a percentage of the total Federal Marine Science effort. In 1958, 1959, and 1960, oceanographic research represented roughly 50 percent of the total marine science budget. From 1962 to 1966 it dropped from 40 to 45 percent. Redefinition of the National Oceanographic Program does not allow us to follow the trend easily, but between 1966 and 1977 the oceanographic research budget dropped another five percent in relation to the Total Federal Marine Science Program.

In terms of constant dollars the Total Federal Marine Science Program gained fitfully from the early 1950's until 1972, then declined in 1973 and 1974 to the 1971 funding level before leveling off in 1975 and 1976. The oceanographic research component, however, oscillated continuously from 1966 through 1972, but demonstrated a net funding increase of over 30 percent for the period. After reaching the high water funding mark in 1972, constant dollar oceanographic research support dropped precipitously through 1976, declining to almost the 1967 funding level.

LARGE SCALE OCEANOGRAPHIC RESEARCH

As oceanography has expanded and matured, the pressures to adopt new modes of inquiry have increased. Traditionally a small scale enterprise -- stressing individualistic, discipline oriented, and autonomous investigations -- since

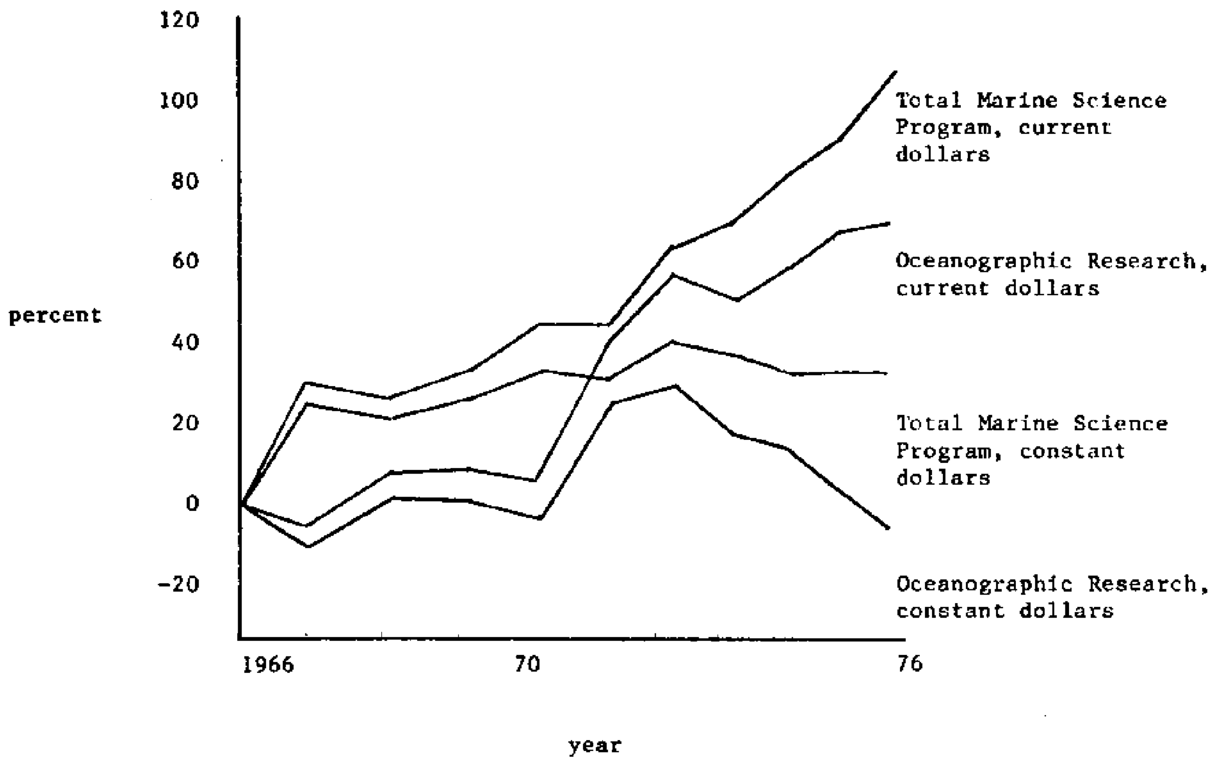

FIGURE 4. CUMULATIVE PERCENT INCREASE/DECREASE IN THE TOTAL MARINE SCIENCE BUDGET AND THE OCEANOGRAPHIC RESEARCH BUDGET, CURRENT AND CONSTANT DOLLARS, 1966-1977

Source: Marine Sciences Council, Marine Science Affairs (Annual Report 1967-1971), Washington, D.C., Government Printing Office; The Office of Science and Technology, The Federal Ocean Program, (Annual Report 1971-1974) Washington, D.C., Government Printing Office; Federal Council for Science and Technology, The Federal Ocean Program Budget Summary Fiscal Years 1975-1977, Washington, D.C., Government Printing Office (March 1976).

the mid-1960's large scale studies have begun to play an increasingly important role. Large scale science is mainly team-oriented, interdisciplinary, increasingly interdependent with the larger society and organized around sophisticated scientific hardware (Hagstrom, 1964; Weinberg, 1966;1970).

Hardware or machinery is the centerpiece of large scale science. Earth orbiting satellites, interplanetary spacecraft, oceanographic research vessels, and submersibles are all prominent examples. These machines represent enormous financial investments and technologies and give scientists the opportunity to explore vastly expanded scientific horizons. But the machines demand an approach to scientific research that is fundamentally different than the old, small scale mode of inquiry.

The first characteristic of large-scale science is its team orientation. Teamwork is not really new to science, since scientists have always worked with their graduate students and collaborated with fellow scientists; but the highly structured formal teams necessary to conduct a great many science projects today is new. The degree to which team science now dominates the enterprise is dramatically illustrated in Figure 5. By 1977 more than 50 percent of the papers were published by three or more investigators.

The hardware of modern large scale science requires

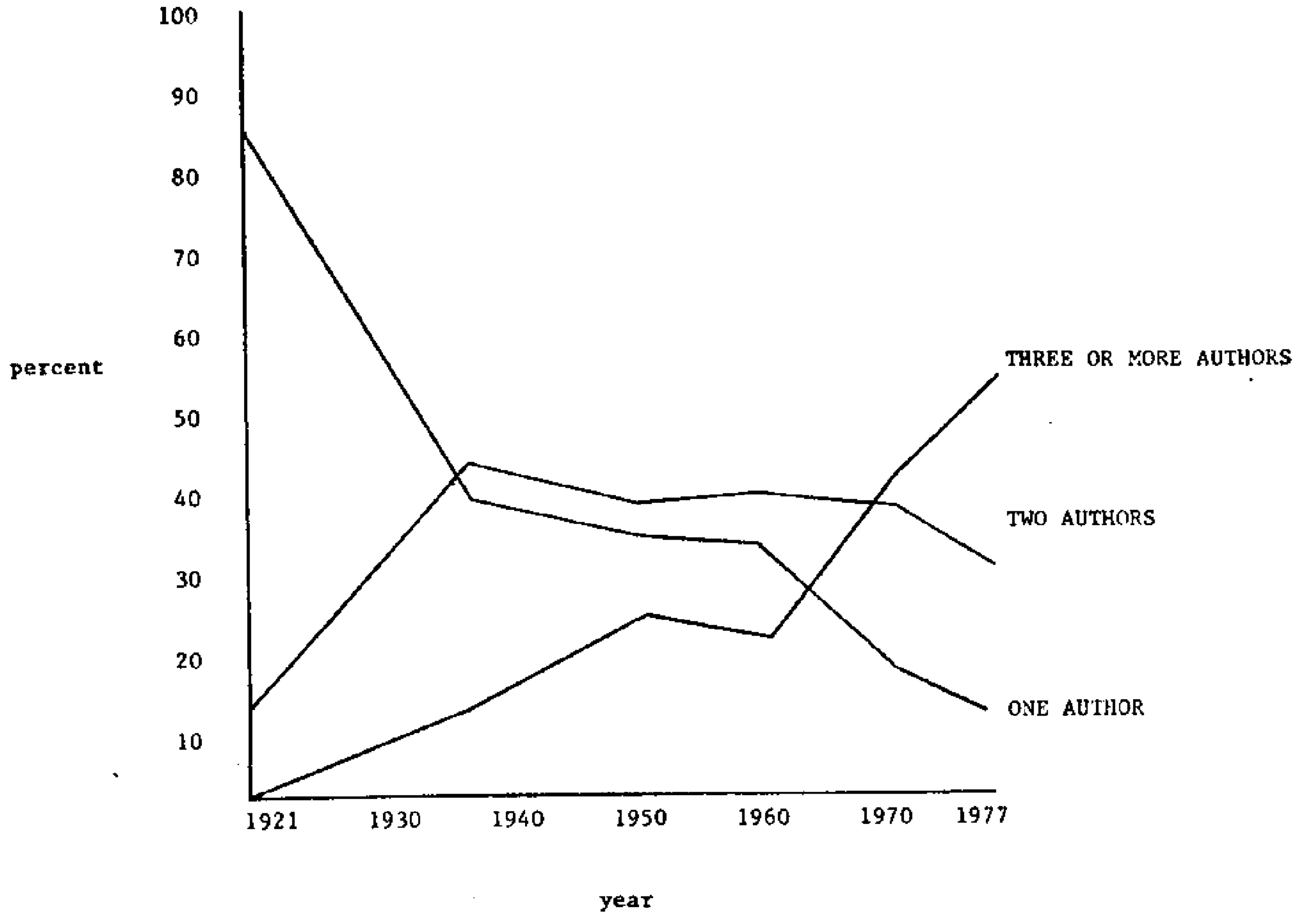

FIGURE 5. PERCENT OF SCIENCE PAPERS PUBLISHED BY ONE, TWO, OR THREE OR MORE AUTHORS, SELECTED YEARS 1921-1977

Source: George Bush, "Teamwork and Research: A Commentary and Evaluation" in George Bush and Lowell Hattery ed. Teamwork in Research, Washington, D.C., The American University Press. Figures for 1960 to 1977 were computed by the author according to the same methodology employed by Bush.

the cooperation of many scientists, professional technicians, and graduate assistants, organized according to a strict division of labor. It is the job of the scientist to develop the hypotheses and lead the group to the solution of its scientific problems. The technicians' responsibility is to develop the means to solve the problems and to handle the day-to-day operations of the machinery. Graduate students usually record much of the data and otherwise function in whatever capacities their mentors deem appropriate. They are often given small sections of the research from which to write their theses (Hagstrom, 1964; Klaw, 1968). The organization of modern large scale science extends even further to the funding sponsor which is most often the Federal government. The funding agency dispenses the funds, oversees the smooth flow of the research, and broadly guides the project's research directions.

The second characteristic of large scale science is its interdisciplinary nature. As the fields of science have become more specialized, fragmented, and arcane, some scientists have responded by attempting to build interdisciplinary bridges to cross the gaps. Questions pertaining to climate prediction and pollution control, for example, are far ranging and require the skills of a broad array of scientists.

The third characteristic of large scale science is its greater interdependence with society. Large scale science is funded at significantly higher levels than more traditional science; this raises important questions of social control, particularly when the principal financial supporter is the Federal government (Weinberg, 1961:161).

In the mid- to late 1960's several large scale oceanographic projects were initiated by the Federal government, two of which are discussed here. The Deep Sea Drilling Program (DSDP) of the Ocean Sediment Coring Program (OSCP) began operation in 1968. Its purpose was to collect ocean bottom sediment cores, hitherto beyond the reach of oceanographers, that might provide confirmation for theories of sea floor spreading (Heirtzler and Maxwell, 1978:3-12).

Development of the <u>Glomar Challenger</u> provided the technological wherewithal to drill previously inaccessible sites. The research vessel is over 400 feet long and displaces 10,500 tons. It is equipped with a gyroscopically controlled roll stabilizing system that allows it to remain in a relatively fixed position over a drilling site without benefit of anchors. It also possesses several drilling innovations that allow it to penetrate much further into the ocean bottom than had previously been possible (NSF, 1973:6).

In 1968 the OSCP, funded through the Earth Sciences Division of the National Science Program, received approximately $4 million to begin the project. Since then the project has grown steadily, and by 1977 the estimated budget was $13 million. Over the ten year course of the project it has received more than $90 million.

The Deep Sea Drilling Project is large scale science in the sense that it focuses on a central piece of state-of-the-art hardware, involves long-term support, requires a complex--for oceanography--management structure, and necessitates the coordination and cooperation of numerous scientists and support personnel.

The New York Bight[a] Project is one of three large scale oceanographic investigations supported by the Marine Ecosystems Analysis Program in the National Oceanic and Atmospheric Administration. The purpose of the New York Bight Project is to "assess the present condition of the Bight ecosystem and its capacity to withstand further degradation (NOAA, 1976;2). Two objectives of the Project are:

> To determine the fate and effects of pollutants on the New York Bight ecosystem, with particular emphasis on ocean dumping;
>
> To identify and describe the important subsystems, processes, and driving forces operating in the New York Bight as a whole and to define their interrelationships and rates of change (NOAA, 1976:2).

The Project is "an integrated study of the physical, chemical, geological, and biological characteristics of the marine environment" (NOAA, 1976:2). The scientific research is conducted primarily by NOAA employed scientists, with university scientists and private industry contractors performing a smaller part of the work. The Bight project

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[a]The Bight includes 15,000 square miles of ocean on the continental shelf south of Long Island and east of New Jersey.

is managed through a NOAA Project Manager and his staff. The New York Bight project was initiated in 1973 and expects to conclude operations by 1980. It has been funded at between $1 million and $3 million in each year of operation. This is considered large-scale science not because it utilizes a central piece of hardware such as the Glomar Challenger, but because it involves a cooperative team of scientists focusing on a multi-disciplinary problem that requires long-term investigation and substantial financial support.

In all, large-scale oceanography accounted for approximately $40-$50 million in 1977, which was approximately 28 to 36 percent of the oceanographic research budget and 5 percent of the Total Federal Marine Science Program budget.

The following chapters focus on another large scale oceanographic undertaking, examining the pulling and tugging of organizational and scientific interests in the formulation and execution of the program. The IDOE, like the New York Bight Project, is a program to sponsor a wide ranging array of projects in areas of national importance. The projects themselves vary greatly in terms of the hardware employed, the number of scientific and technical personnel involved, and the scope of the problems under investigation.

CHAPTER II

ORGANIZATIONAL DEVELOPMENT: PRE-ORGANIZATIONAL POLICY INFLUENCES

INTRODUCTION

The Decade concept was debated for several years by government officials and marine interests before Vice President Spiro Agnew, as Chairman of the National Council of Marine Resources and Engineering Development, announced the establishment of the International Decade of Ocean Exploration (IDOE) and assigned administrative responsibilities to the National Science Foundation (NSF). In many respects the events that preceded the establishment of the new agency were as critical for later policy decisions and patterns of organizational behavior as any that followed its implementation. In effect, IDOE's identity was molded even before it was formally created.

Three of the most important elements that helped shape IDOE's character were:

-- the channels of government through which the concept was developed;

-- the nature of its support;

-- its location, or assignment in the Federal bureaucracy (Rourke, 1969; Seidman, 1975).

The following chapter is a review of the historical, political and institutional contexts of these elements, and an analysis of their significance for IDOE policy making.

THE COUNCIL

IDOE was the brainchild of the National Council on Marine Resources and Engineering Development (also known as the Marine Sciences Council, or the Council), which was established by congressional initiative in 1966 and located in the Executive Office of the President. The legislation which founded the Council intended that it

> develop, encourage, and maintain a coordinated, comprehensive, and long-range national program in marine science for the benefit of mankind to assist in protection of health and property, enhancement of commerce, transportation, and national security, rehabilitation of our commercial fisheries, and increased utilization of these and other resources (U.S. Congress, 1966).

The awesome mandate of the Council was to be met through several courses of action encouraging:

1. The accelerated development of marine resources,
2. The expansion of marine environmental knowledge,
3. The encouragement of private enterprise to utilize marine resources,

4. The preservation of the leading role of the United States in marine science and resource development,

5. The advancement of marine science education and training,

6. The development and improvement of marine technology,

7. The effective utilization and coordination of the scientific and engineering resources of the United States,

8. The cooperation by the United States with other nations in marine science activities (U.S. Congress, 1966).

The high-level membership of the Council accentuated the seriousness of ocean issues in the mid-1960's, and eased the pursuit of Council objectives. The Secretaries of State, Navy, Interior, Commerce, Health, Education and Welfare, and the Treasury were included in the Council because of their marine-related responsibilities, as well as the Chairman of the Atomic Energy Commission, the Director of the National Science Foundation, and the Vice President, who served as Chairman.

The day-to-day administrative activities and substantive policy work of the Council were performed by a small staff, led by Dr. Edward Wenk, Jr., Executive Secretary. A highly respected ocean engineer and veteran of the politics of science and technology policy on Capitol Hill, Wenk had earlier served as the first Science Advisor to Congress. Council operations were supplemented by the use of outside consultants and a committee infrastructure that drew upon talent from the member agencies (Wenk, 1972:107).

The Decade concept emerged in rudimentary form from the first Council meetings as an outgrowth of the objective to seek "cooperation... with other nations and groups of nations and international organizations in marine science activities when such cooperation is in the national interest" (U.S. Congress, 1966; U.S. Congress, House, 1968:213). The development of the program was hastened as a reaction to the specific proposal of Ambassador Arvid Pardo of Malta, at the United Nations, to restrict the unilateral exploitation of marine mineral resources on the deep seabed. The Decade was offered by the United States as a counter proposal that would provide for a long term research and exploration effort to determine the location and value of the oceans' resources, and would delay consideration of a new ocean regime.

Because of the international significance of the Decade proposal and the suggested scope of its research and exploration components, the Decade generated interest throughout the government. It also received the enthusiastic support of the Vice President and Council Chairman, Hubert Humphrey, who had intense foreign policy interests.

Shortly after establishment of the Council, President Lyndon Johnson, too, expressed his willingness to pursue a broad scale, international approach to marine issues. In his speech on July 13, 1966, commissioning the Oceanographer, he declared "that truly great accomplishments in oceanography will require the cooperation of all the nations of the world" (Johnson, 1966). In characteristic fashion, President Johnson was helping to lay the foundation for a "think big" approach to marine issues that would eventually crystalize into the IDOE.

The Council quickly took advantage of the President's statement, and by early 1967 evolved a broad strategy upon which to pursue Decade development. The five part strategy included the following elements:

1. to characterize scientific, political and economic goals of the United States that would be enhanced by multinational exploration;

2. to estimate scientific capabilities needed to achieve these goals;

3. to examine U.S. mechanisms of expedition planning and deployment that would blend in and out-of-house scientific interests and personnel;

4. to identify problems in gaining overseas cooperation (including problems of internal communication within other nations), the state of their capabilities, and the extent to which their interest would be confirmed by funding;

5. to consider needed and available international apparatus (Wenk, 1972:215-6).

Shortly thereafter, Joseph Califano, Special Assistant to the President, asked members of the Executive Office councils and those in various corners of the bureaucracy for proposals that might be incorporated into

President Johnson's State of the Union Address -- more than six months away. The Council was requested to submit proposals through this mechanism and replied with eight suggestions, one of which was the Decade concept. Although nothing came of the exchange, a similar request from Presidential Science Advisor Donald Hornig and Council reply did spur Executive Office interest. By this time, September 1967, the Decade concept had been honed somewhat by the Council staff and the specific title "International Decade of Exploration" had been added. In November Califano convened a special task group to winnow down the marine affairs recommendations -- which had grown to fifteen. "From the Califano soiree came a green light to move on five marine affairs issues" (Wenk, 1972:229). The five recommendations, including the Decade, thus moved through Califano's ad hoc channels to the President's desk for consideration for the upcoming State of the Union Address. A longer list of twelve marine related recommendations traveled through institutional channels for Presidential consideration (Wenk, 1972:229). Finally, in his Address to the Congress President Johnson stated: "This year, I shall propose that we launch with other nations an exploration of the ocean depths to tap its wealth and its energy and its abundance..." (Wenk, 1972:230). In the words of the Executive Secretary of the Council, "it was as if we had captured the brass ring on the merry-go-round--while blindfolded" (Wenk, 1978).

President Johnson expanded on his concept of the Decade in his March 8, 1968 Conservation Message.

> Even in the Age of Space, the Sea remains our greatest mystery. But we know that in its sunless depths, a richness is still locked which holds vast promise for the improvement of men's lives--in all nations.
>
> Those ocean roads, which so often have been the path of conquest, can now be turned to the search for enduring peace.
>
> The task of exploring the ocean's depth for its potential wealth -- food, minerals, resources-- is as vast as the seas themselves. No one nation can undertake that task alone. As we have learned from prior ventures in ocean exploration, cooperation is the only answer.
>
> I have instructed the Secretary of State to consult with other nations on the steps that could be taken to launch an historic and unprecedented adventure--an International Decade of Ocean Exploration for the 1970's (Johnson, 1968).

But even at this point the IDOE concept was still in its embryonic stages.

The President committed the United States, via the Decade program, to:

> Expand cooperative efforts by scientists from many nations to penetrate the mysteries of the sea that still lie before us;
>
> Increase our knowledge of food resources, so that we may use food from the sea more fully to assist in meeting world-wide threats of malnutrition and disease;
>
> Bring closer the day when the peoples of the world can exploit new sources of minerals and fossil fuels (Johnson, 1968).

Two months later (May 9, 1968) the Council published its first Decade related document, International Decade of Ocean Exploration, which elaborated on President Johnson's Conservation Message reference to the Decade. The "white paper," as it was called, was developed by a working committee of the Council under the leadership of Dr. Robert White, Director of the Environmental Science Services Administration (ESSA), and staffed by individuals from several Federal marine agencies. The report was distributed widely among national and international oceanographic circles as a basis for discussion. The Decade was envisioned in the report as a period of planning, development and execution of national and international programs of marine resource identification and assessment, geographic exploration, and scientific research and surveys on a national and international scale, (Marine Sciences Council, 1968:1-3). Illustrative objectives of the Decade as suggested in the "white paper" included:

Exploration of Living Resources

> assessment of living resources useful to man in uncharted regions of the world;
>
> assessment of current utilization of known fishery stocks;
>
> acquisition of knowledge relating living resources to their environment in order that greater efficiency in their capture and conservation can be achieved;

Exploration of the Ocean Floor

> determination of the geological structure and

mineral and energy resource potential of the world's continental margins;

preparation of topographic, geological, and geophysical maps of selected areas of the deep ocean floor;

coring and drilling on the continental margins and deep ocean floor in selected areas;

Exploration of Ocean Processes

study of scales of motion in the sea and the dynamics of ocean current systems;

investigations of surface boundary processes, such as the growth and propagation of ocean waves;

investigations of evolutionary processes, of ocean basins;

Assistance to Developing Nations

mapping of selected areas of the Continental Shelf of developing nations;

surveys of the coastal fishery resources of the developing nations (Marine Sciences Council, 1968:4-5).

Following publication of the "white paper" the Council formulated an elaborate planning structure that it hoped to initiate forthwith for continued development of the Decade concept.

The planning mechanism was to be centered around a joint government/non-government planning staff that would be located in the Executive branch--most likely at the National Science Foundation, because of its role in previous international science enterprises--and directed by a distinguished member of the science community. The planning staff would report to the Council and receive policy advice from that body. The joint planning staff would, in turn, offer specific program recommendations and coordinate the many national and international program offices. Advisory assistance would be provided to the joint planning staff through independent interests such as the National Academy of Sciences (NAS), National Academy of Engineering (NAE), commercial, industrial, and State bodies, and by Council committees for international policy guidance. In addition, the Council committees would provide a review function for the decisions, recommendations, and operating procedures of the joint planning staff (Marine Sciences Council, Minutes, 1968b:7).

However, this elaborate planning mechanism was never implemented because of the reluctance of the scientific community to enter into any organizational structure responsible to the Council or any other government agency. (More will be mentioned on the role of the scientific community in the next section).

The program languished for two months as the Council attempted to reach an accommodation with the scientific community. Unsuccessful, the Council reluctantly postponed the planning apparatus and went ahead with a contract to a joint committee of the National Academy of Sciences and the National Academy of Engineering (NAS-NAE) to formulate recommendations on the scientific aspects of the

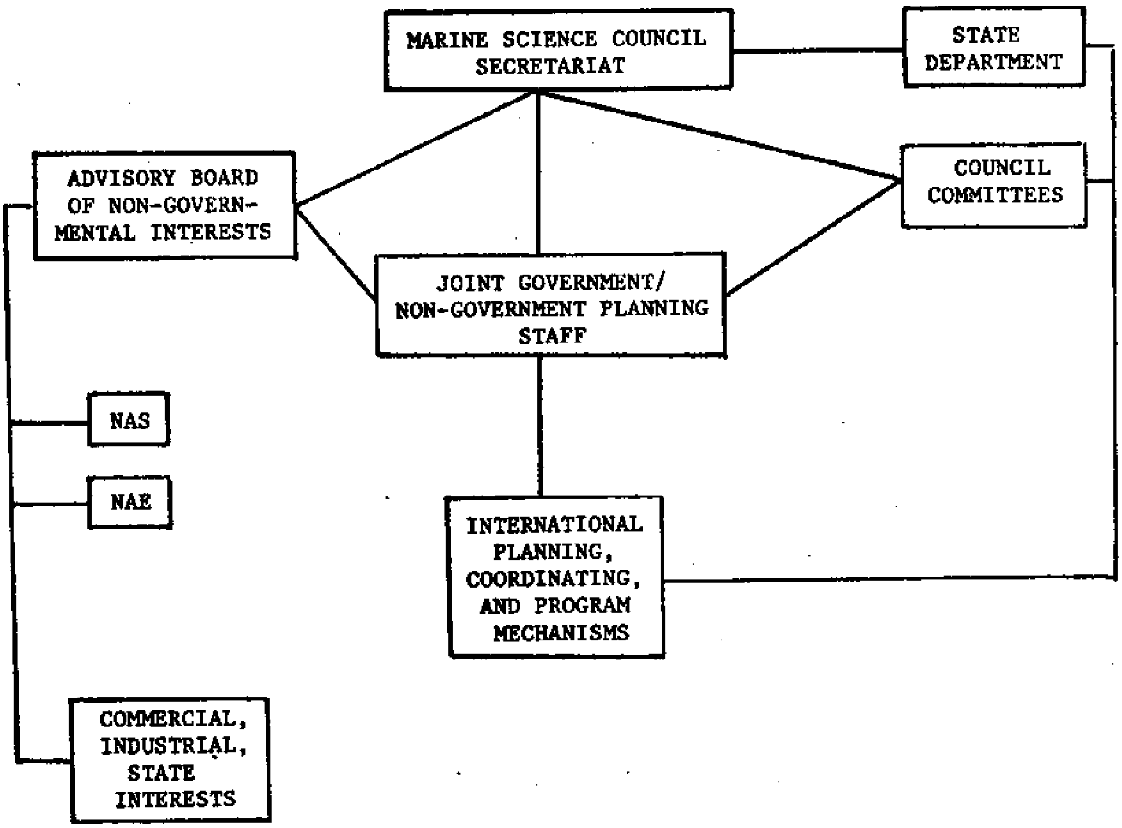

FIGURE 6. PROPOSED INTERIM ORGANIZATION FOR PLANNING U.S. PARTICIPATION IN AN INTERNATIONAL DECADE OF OCEAN EXPLORATION

Source: Marine Sciences Council, Minutes of the Meeting, April 30, 1968:9.

Decade. The NAS-NAE document, An Oceanic Quest, was released one year later in June 1969. (The findings are reported in the next section).

Earlier that year, in January 1969, the Commission on Marine Science, Engineering and Resources,created by the same legislation that established the Council and responsible for developing a long-range plan for marine affairs in the United States, released its report, Our Nation and the Sea: A Plan for National Action. The report included a brief endorsement of the Decade concept and the suggestion that the planning staff be located in a yet-to-be-established National Oceanic and Atmospheric Agency (Commission on Marine Science, Engineering and Resources, 1969:175).

The release of the Commission report and the subsequent publication of the NAS-NAE report, An Oceanic Quest coincided with the change of Presidents from Lyndon Johnson to Richard Nixon. With the new Adminstration came questions of whether the Decade plans would be advanced or rejected. The uncertainty was quickly resolved. "The Nixon administration move(d) swiftly to consider the unfinished business of its inheritance and at the February 1969 session of the Council under the authority of the new Chairman, Vice President Agnew, the Decade was accepted for priority study and instructions for early review" (Wenk, 1972:245-6).

But problems surfaced in subsequent Council meetings that threatened to abort the Decade. There were interagency conflicts within the Council among agencies fearful of

Decade intrusion into their administrative jurisdictions. The agencies were also "alarmed that if the plan succeeded it would be at the expense of old favorites" (Wenk, 1972: 247).

A revised and strengthened plan for the Decade was developed throughout the summer of 1969 by the Robert White group and by Council staff members. Their report, International Decade of Ocean Exploration: Program Recommendations utilized An Oceanic Quest and other scientific documents, as well as interagency considerations for the planning and implementation devices (1969). In addition, the report went through a "full and frank" review before the members of the Council's Committee for Policy Review which further revised the scientific content "to increase emphasis on environmental quality goals and to suppress emphasis on resource development, including fisheries" (Wenk, 1972:248).

Specifically, the long-term goals that were considered to warrant the highest priorities in seven areas were:

A. Environmental Quality - Provide the scientific basis for identifying pollutant build-up and ecological degradation and for managing waste disposal in the ocean by establishing ecological and chemical baselines, monitoring pollutant inflow, and ascertaining effects of pollutant accumulation.

B. Environmental Forecasting - Reduce hazards to life and property and permit more efficient utilization of marine resources by improving physical and mathematical oceanic and atmospheric models which will provide the basis for environmental forecasting of greatly increased accuracy, timeliness, and geographic precision.

C. Seabed Assessment - Permit better planning, conduct, and management of ocean mineral exploitation, construction, and navigation by acquiring needed knowledge of seabed topography, structure, physical and dynamical properties, and mineral resources.

D. Fisheries Exploration - Increase the contribution of fishery resources to the Nation's economy; double the availability and consumption of fishery products in protein deficient countries by 1980; and improve the basis for management of international fisheries. (Excluded from final version).

E. Sensor Development - Acquire by 1980 an enhanced capability to make useful predictions of marine environmental conditions on operationally significant time scales through development and deployment of a cost-effective synoptic oceanographic data acquisition system consisting of an optimum mix of platforms, sensors, and communication networks, together with their associated support facilities.

F. Data Sharing - Improve usefulness and availability of marine data, information, and data products by modernizing and standardizing national and international marine data collection, processing, and distribution.

G. Coastal Charting - Reduce risks of life and property by improving the ready availability of up-to-date charts of foreign coastal areas through strengthening the capability of developing countries to contribute to international hydrographic activities.

Specific recommended program elements were:

Environmental Quality

research and development to identify biological indicators of ocean quality, understand processes controlling biomass, upgrade marine taxonomy capabilities, improve capabilities to beneficially modify the biological composition of the ocean, and develop a strategy for ocean ecological research;

traverse the Atlantic, Pacific, and Indian

Oceans, on a semi-synoptic basis, with 120 vertical profile stations to establish broad chemical baselines; add 50 U.S. estuarine stations to the existing 30 to monitor the inflow of natural and man-generated dissolved and particulate constituents; undertake pilot studies of five different types of estuaries and embayments to determine the best parameters to observe systematically for water-quality monitoring and surveillance; and analyze existing data on physical, chemical, and geochemical interactions in fresh water and salt-water coastal zones;

develop ocean surface monitoring techniques.

Environmental Forecasting

formulate mathematical models which simulate large-scale dynamic processes of the oceans so that forecast products based on synoptic observations can be developed;

develop improved wave forecasting models;

conduct concentrated environmental studies of regions selected as model oceans and in particular study the Gulf of Mexico as an area which has a major influence on the weather over the Southeastern U.S.;

Seabed Assessment

prepare bathymetric, geophysical, and geological maps of selected areas in the Gulf of Mexico, Bering Sea, Beaufort Sea, Gulf of Mexico, Gulf of Maine, and the Washington-Oregon coast;

elucidate the tectonic framework, evolution, and mineral potential of the Gulf of Mexico/ Caribbean and the Bering Sea small ocean basins by geophysical surveys, sediment sampling and deep drilling; conduct systematic resource investigations in the deep oceans, initially in the area of the mid-Atlantic ridge/rift zone;

carry out airborne magnetic surveys with other Decade seabed investigations.

Fisheries Exploration (Excluded from final version).

establish a national fishery resource evaluation center for the Atlantic Ocean and Mediterranean Sea, and a second center for the Pacific and Indian Ocean; train personnel from developing nations at these centers in resource assessment techniques to develop estimates of standing stock;

prepare maximum sustainable yield estimates of currently used and potential world fishery resources based upon the standing stock estimates, and provide technical assistance in production, processing distribution and marketing to increase local consumption of fishery products abroad;

conduct intensive exploratory fishing to systematically map the fishery resources of the U.S. Continental Shelf to develop a timely resource availability forecasting system and to provide a better biological basis for national and international fishery management.

Sensor Development

conduct research and development on unmanned automatic marine environmental data buoys including hull, mooring, sensor, data handling and telemetry, servicing, power supply, and other buoy subsystems and carry out design studies for optimum mix of buoys and other platforms;

carry out R&D in support of data acquisition system development including development of a marine environmental data collection communications network concept;

implement early improvements of oceanographic data acquisition by instrumenting existing platforms;

develop supporting automated sensor/transducer subsystems for ships, aircraft, satellites and fixed structures.

Data Sharing

prepare inventories of available data and data products: data collecting, processing, and disseminating services; oceanographic forecasting services; and bibliographic, indexing, abstracting, and information services. Process backlogged data of high quality and distribute it among centers;

Coordinate Decade planning of real-time data and forecasting systems (IGOSS) and with other international data activities (CICAR and GEP). Establish standards for instrument calibration and data reduction, documentation, and formats.

Develop modern management techniques to implement data and infromation programs. Provide for rapid data exchange both nationally and internationally by strengthening data centers and by utilizing computer technology and advanced communication systems.

Coastal Charting

carry out cooperative hydrographic survey programs for Latin American countries;

begin implementation of survey programs in two Southeast Asian nations;

begin planning surveys in Africa (Marine Sciences Council, 1969, Enclosure 3:1-7).

Program Recommendations represented the most comprehensive planning effort to date for the Decade. It utilized all previously published Decade plans and enlarged on them by providing detailed program descriptions, alternative suggested funding levels for FY 1971-1974, an outline of Federal, non-Federal, and international benefits that would accrue from the Decade, and consideration of Decade implementation.

Program Recommendations retreated from earlier considerations which had envisaged Decade programs being financed from the budgets of all relevant agencies, administered jointly by several participating agencies, and directed by a small planning staff located in one of the agencies. The Council feared that such an arrangement would "result in undesirable pressures to divert resources from essential programs supporting agency missions to more highly visible Decade programs" (Marine Sciences Council, 1969:15). Instead, the report recommended that "a substantial block of funds for Decade programs should be included within a single agency budget--preferably NSF block funding for the scientific portions--with other program elements funded by concerned agencies. All of these funds should be considered as above-ceiling items and protected throughout the budgetary process as such". (Marine Sciences Council, 1969:19-16). In addition, the suggestions relating to fisheries exploration and research were withdrawn at the last moment to allay the fears of agencies with programs in this area.

The Decade, as it was now described, proceeded to the President's desk for consideration, in company with several other marine affairs items, all spurred by congressional dissatisfaction with the lack of administration initiatives in this area (Wenk, 1972:247). On October 16, 1969, the "brass ring" was recaptured by the Council, and on October 19 Vice President Agnew made the announcement of the Administration's intention to initiate the IDOE. As recommended by the Council, Agnew later assigned lead agency responsibility to the National Science Foundation to plan, manage, and implement the new program.

THE SCIENTISTS

The marine science community was involved from the earliest developmental stages of IDOE, primarily through their representatives in the marine affairs agencies of the Federal government. The Council also hired marine science consultants throughout the planning stages of IDOE, and their opinions were solicited. However, organized scientific input was minimal until the Council contracted with the National Academy of Sciences and the National Academy of Engineering (NAS-NAE) in July 1968, to "examine the scientific and engineering goals and priorities among these goals, the capabilities required to achieve them, the program elements of a Decade of Ocean Exploration, and end products and benefits to be anticipated if the Decade were to be implemented" (NAS-NAE, 1969:v).

Until then, the basic science community had expressed extreme reluctance to participate in any program so heavily weighted with political considerations. This reluctance was dramatically illustrated by the unwillingness of the scientists to partake in the planning structure developed by the Council, because it would require the scientific leader of the planning mechanism to be placed under Council control.

The scientists were successful, however, in persuading the Council to let them conduct an independent report on the scientific aspects of the program. The report, An Oceanic Quest, was released in June 1969. It was based on a three-week workshop held at the Woods Hole Oceanographic Institution from September 4 to 13, 1968. The NAS-NAE group worked together "to identify programs of exploration effort that could contribute to enhancing utilization of the ocean" (NAS-NAE, 1969:vi). A smaller steering group continued to meet for several months after the workshop to develop and refine the suggestions and to work out other details, including a prospective budget.

Before the report was published it was "reviewed in detail by the Committee on Oceanography, the Committee on Ocean Engineering, all participants of the Woods Hole Workshop, government agency representatives, representatives of the NAE Council, a representative of the Earth Sciences Division of the National Research Council, and selected scientists and engineers who had not participated in the preparation of the report" (NAS-NAE, 1969:vi). But final responsibility for the material included in the report belonged to the Steering Committee, chaired by Dr. Warren Wooster.

The Committee identified the basic objective of the Decade:

> To achieve more comprehensive knowledge

> of ocean characteristics and their changes and more profound understanding of oceanic processes for the purpose of more effective utilization of the ocean and its resources (italics in original) (NAS-NAE, 1969:8).

Based on this objective, several goals were outlined that would lead, over the proposed ten-year period of the Decade, to an enhanced capability to:

> Exploit, conserve, and manage in a rational, economic manner the major living resources of the ocean, and the major non-living resources of the continental margin.
>
> Evaluate realistically the economic potential of the non-living resources of the deep-sea floor and provide the factual basis for rational decisions about their jurisdiction.
>
> Make useful predictions of oceanic conditions on operationally significant time scales.
>
> Control modifications of the marine environment resulting from man's intervention.
>
> Operate effectively at the surface, within, and at the bottom of the ocean (NAS-NAE, 1969:8-9).

The summary list of programs to meet the above goals was a long one and was divided into four rough subject categories. The categories and the principal programs of each were:

Geology and Non-living Resources

> International cooperative reconnaissance of the emerged and submerged

continental shelf of the eastern margin of the Atlantic, from northern Norway to the Cape of Good Hope...

International cooperative geological-geophysical surveys of the contiguous shelves and slopes of different countries.

Assistance to coastal states in detailed hydrographic surveys in near-shore waters and harbors.

Cooperative hydrographic survey and charting of the continental margins.

Geological-geophysical investigations of selected basins for assessment of mineral-resource potential...

Continuation of the deep-sea drilling program...

On mid-ocean ridges, geological and geophysical studies involving precise navigation and hardrock sampling capability with manned and unmanned devices and surveys for hydrothermal deposits.

Studies of a trench at a continental margin, with dredging and coring at sea and sampling on land, geophysical profiles both at sea and ashore, and detailed earthquake seismology studies of submarine earthquakes using land-based seismometers.

Systematic, course-scale surveys of the deep ocean to provide a basis for more-intensive reconnaissance of resources. Broad scale reconnaissance geophysical surveys and deep coring to yield regional sediment description.

In the South Pacific, survey selected sites for manganese nodules and phosphorite deposits to ascertain their distribution and composition.

Extend magnetic coverage... to ... improve the global picture of gravity...

Biology and Living Resources

> To explore, and assess the production potential of the numerous latent living resources in the Gulf of Mexico and Caribbean Sea, and in the Gulf of Alaska...
>
> To explore the stocks of oceanic tuna and tuna-like fish... and to devise suitable means for their utilization.
>
> To investigate and describe the interactions in the great multispecies... thus providing the scientific basis for the establishment of management policies for these fisheries.
>
> To explore and assess the production potential of the oil sardine, mackerel, shrimp, and other fisheries of the Arabian Sea...
>
> To investigate the resource potential of krill and... to devise means for their extraction...
>
> ... assess the fishery resources of southern Chile and Argentine, especially... where local industries might be encouraged.
>
> ...explore and assess the fishery resources of the continental shelf of the Indonesian archipelago... especially with regard to stocks of demersal fishes and prawns.
>
> ...to use... models... to guide the design of observational programs.
>
> To apply recently developed techniques to the study of food chains in the sea, and to develop new techniques of measuring biological parameters...

Physics and Environmental Prediction

> Extend the use of selected ships of opportunity and aircraft for collection of near-surface oceanographic data. Encourage the establishment in developing countries of simple shore stations...

> Establish more permanent ship and island mid-ocean monitoring stations...
>
> Investigate the requirements for design of an effective system for oceanographic monitoring of the North Pacific.
>
> Support pilot studies of new monitoring techniques...
>
> In the Western Indian Ocean, investigate reaction of the ocean to monsoonal changes in winds, using an existing numerical model to design an observational program.
>
> In the Western Pacific and China Seas, use existing data to construct a preliminary numerical model.
>
> In the Equatorial Pacific, conduct an observational program... to elucidate large-scale, long-term ocean-atmosphere interaction.
>
> Select a subtropical upwelling region for the investigation of mesoscale interactions.
>
> Complete world coverage of deep-water temperature, salinity, and dissolved-oxygen measurements.
>
> Geochemistry and Environmental Change
>
> Conduct a geochemical survey of selected chemical and radiochemical substances on meridional traverses of the Atlantic, Pacific, and Indian Oceans.
>
> Monitor the rate at which natural and man-made substances are being added to the ocean by rivers and winds (NAS-NAE, 1969:13-16).

To complete this vigorous program of scientific research, survey and exploration, the scientists requested a first year budget of at least $100 million and made it emphatically clear that if financed at lower levels "it would be undesirable to identify the set of programs as an International Decade of Ocean Exploration" (NAS-NAE, 1969:87). The report specifically declined to recommend that Decade planning responsibilities be assigned to any particular agency, "as neither Congress nor the Executive had yet acted on the organizational recommendations of the report of the Commission on Marine Science, Engineering and Resources" (NAS-NAE, 1969:102).

The only other organized involvement in Decade planning was on the international scene.

THE INTERNATIONAL CONTEXT

World interest in the economic potential of the oceans developed rapidly in the early to mid-1960's as exploitation of land-based resources in the developed countries seemed to approach Per limits and as the technologies for marine exploitation evolved. In 1966, therefore, the United Nations assumed the responsibility of conducting a survey of the present state of knowledge of non-living resources beyond the continental shelf, and requested the formulation of proposals for an expanded program of international cooperation in their exploration(United Nations General Assembly, 1966).

At the next session of the General Assembly (the 22nd in 1967), however, the issue took on political overtones when Ambassador Arvid Pardo of Malta proposed that the deep ocean seabed be internationalized for the benefit of the underdeveloped countries as well as the developed ones.

The Pardo proposal was tabled, but the General Assembly adopted a resolution (UNGA Resolution 2340, 1967) establishing an Ad Hoc Committee:

> to prepare a study on various aspects of the seabed beyond national jurisdiction... The study would examine (1) activities of the United Nations and its specialized agencies related to the seabed; (2) relevant international agreements; (3) scientific, technical, economic, legal, and other aspects of the question; and (4) suggestions regarding practical ways of promoting international cooperation in the exploration, conservation, and use of the seabed and its resources (Wenk, 1972:237).

The final report of the Ad Hoc Committee made four recommendations that it hoped would supplant consideration of the Pardo regime for the oceans. The General Assembly adopted the suggestions of the committee (UNGA Resolution 2467, 1968) and resolved in the fall of 1968 to:

> 1. Replace the ad hoc arrangement with a 42-member standing Committee on the Peaceful Uses of the Seabed and the Ocean Floor Beyond the Limits of National Jurisdiction, to expend the studies carried out earlier by the Ad Hoc Committee:
>
> 2. Urge measures to prevent pollution of the oceans;
>
> 3. Support the U.S. proposal for International Decade of Ocean Exploration within the framework of a comprehensive long-term program of scientific investigation and call on the IOC to play a leading role in coordinating the program; and
>
> 4. Request the Secretary General to study the question of establishing international machinery to promote exploration and exploitation of seabed resources and their use (Wenk, 1972:238).

But, by June 1968, the Intergovernmental Oceanographic

Committee, the principal U.N. vehicle for marine science affairs, had already taken "a number of steps to initiate development of the expanded program (of exploration), including the inviting of its advisory bodies, SCOR[a] and ACMRR[b], together with other interested scientific bodies, to consider its scientific content"(United Nations Educational, Scientific, and Cultural Organization (UNESCO), 1970:27). Shortly thereafter, from April 28 to May 7, 1969, a group of scientists organized jointly by the Food and Agriculture Organization (FAO) and the World Meteorological Organization (WMO) met in Ponza and Rome, Italy, to consider the scientific aspects of an international ocean research program. Their report, Global Ocean Research, commonly referred to as the Ponza Report, was another instrumental document in the development of the Decade concept. It used much of the same scientific expertise an As Oceanic Quest and benefited from the scientific feedback to that report. Five of the seven members of the American delegation to Ponza, Italy, had worked on the earlier NAS-NAE document, An Oceanic Quest.

The group identified four research areas similar to those proposed in the Quest and an assortment of research problems that were also comparable (UNESCO, 1970).

Later in the same session the General Assembly adopted two resolutions favorable to the Decade concept, including one (UNGA Resolution 2414, 1968) which "endorsed the concept

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[a](SCOR) Scientific Committee on Oceanic Research
[b](ACMRR) Advisory Committee on Marine Resources Research

of a coordinated long term program of oceanographic research and requested the Secretary General to present a comprehensive outline of the scope of this program to the Economic and Social Council and to the General Assembly during their 1969 sessions," and the other (UNGA Resolution 2467D, 1968) which endorsed the IDOE as the acceleration phase of the long term and expanded program (UNESCO, 1970: 27).

The U.N. Seabeds Committee report, Comprehensive Outline of the Scope of the Long Term and Expanded Program of Oceanic Exploration and Research, approved by the IOC and adopted by the U.N. General Assembly in September 1969, was a more detailed elaboration of the Ponza and NAS-NAE Reports; it included the same four research areas and an even more comprehensive listing of specific recommended research projects (UNESCO, 1970:9-20).

THE FOUNDATION

Approximately three weeks after announcing the Nixon Administration's plans to support the Decade, Vice President Agnew assigned planning, implementation, and management responsibility to the National Science Foundation. The Foundation is an independent agency in the Executive branch, administered jointly by a director and a National Science Board who share executive responsibilities. Both the director and the board are appointed by the President with the advice and consent of the Senate.

At its establishment on May 10, 1950 the Foundation was authorized and directed

(1) to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences;

(2) to initiate and support basic scientific research and programs to strengthen scientific research potential in the mathematical, physical, medical, biological, engineering, and other sciences, by making contracts of other arrangements (including grants, loans, and other forms of assistance) to support such scientific activities and to appraise the impact of research upon industrial development and upon the general welfare;

(3) at the request of the Secretary of Defense, to initiate and support specific scientific research activities in connection with matters relating to the national defense by making contracts or other arrangements (including grants, loans, and other forms of assistance) for the conduct of such scientific research;

(4) to award, as provided in section 10, scholarship and graduate fellowships in the mathematical, physical, medical, biological, engineering, and other sciences;

(5) to foster the interchange of scientific information among scientists in the United States and foreign countries;

(6) to evaluate scientific research programs undertaken by agencies of the Federal Government, and to correlate the Foundation's scientific research programs with those undertaken by individuals and by public and private research groups;

(7) to establish such special commissions as the Board may from time to time deem necessary for the purposes of this Act;

(8) to maintain a register of scientific and technical personnel and in other ways provide a central clearing house for information covering all scientific and technical personnel in the United States, including its Territories and possessions;

> (9) to initiate and support a program of study, research, and evaluation in the field of weather modification...(U.S. Congress, Senate, 1950:Sec C).

As originally planned, NSF was to be the post-war successor of the Office of Scientific Research and Development (OSRD), which organized the scientific contribution to the War. The hiatus between the conclusion of World War II and the creation of the Foundation in 1950, however, provided an opportunity for other agencies to fill the gap with their own mission-related research operations. Thus, by 1953 the Foundation supported only about 2 percent of the basic science funded by the Federal government. The percentage rose considerably to approximately 20 percent in 1979, but the plualism of federally funded basic science is still one of its striking features.

Because of its position as a newcomer into an arena where there were established and more highly funded R&D operations, the Foundation, through its first Director, maintained that its national science policy coordination charge, its evaluation mandate, and other legislated responsibilities were incongruent with its real position of power in the bureaucracy (Lomask, 1975:ch. 6; Wolfe, 1957). Instead, the Foundation directed its energies to the development of a healthy support system for the basic sciences in all fields (Lomask, 1975:92) Lambright, 1972:7). Eventually most of its other responsibilities were assigned elsewhere (Allison, 1966:78).

In 1968, though, after lengthy hearings in Congress, the NSF Act was substantially amended to broaden its responsibility to support applied research, particularly that relevant to the solution of major national problems. Under pressure, the Foundation established in 1969 a new directorate for the support of problem-oriented research, the Directorate for Research Applications (RA).[a]

The Foundation reacted negatively to the amendment, as organizational attitudes in support of basic scientific research had become ingrained in the spirit and culture of the organization, and because of the fear that change engenders in any organization (Downs, 1969:chs. 16 and 19). The Foundation skillfully succeeded in minimizing the impact of the new applied direction and in isolating it in the organization structure. In 1977 applied science support amounted to approximately 20 percent of all NSF research support.

The Foundation advances its policy of basic and applied scientific support through the so-called project grant method. That is, the Foundation "invites research proposals from individuals or groups of scientists... With the help of individual reviewers in the field involved and of advisory panels appointed by the agency for this purpose, the federal agency selects for support those that are judged to have the

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[a]RA was reorganized in 1978 and its name was changed to the Directorate for Applied Science and Research Applications (ASRA).

greatest scientific merit" (Waterman, 1960:1346). In addition, once funded, the projects are not closely administered; they are required only to submit annual reports of their progress and expenditure information. The system was originally developed by the Office of Naval Research, one of the first federal supporters of basic science, and the organization from which Alan Waterman, the first NSF Director, was recruited.

On November 7, 1969, the Foundation assumed responsibility for planning, implementing and managing the science portions of the Decade. The Decade planning between 1966 and 1969 laid down the framework for the scientific content of the program, its emphasis on international cooperation, and its large scale approach, but beyond that the Foundation was free to integrate the program into its own mode of operation.

ANALYSIS

Government Channels of Development. Two major developments in the early to mid-1960's made the Decade concept timely from American political-economic and scientific points of view. First, the U.N. Malta proposal to internationalize the sea floor threatened any unilateral effort to exploit marine mineral resources at the same time that development of marine technology had advanced sufficiently to make marine mineral exploitation economically feasible. Second, the proliferation of national jurisdictional restrictions out to two-hundred miles from shore by many nations was beginning to intrude on fisheries, shipping lanes, other industries and commerce, and on the abilities of American oceanographers to investigate near-shore marine phenomena. The United States was hopeful that the Decade, with its emphasis on an international program of research and exploitation, would delay the U.N. effort and slow down the pace of national claims to the ocean.

The Council initiative in developing the Decade idea resulted directly from its international marine mandate to work toward "cooperation with other nations and groups of nations and international organizations in marine science activities when such cooperation is in the national interest," and the foreign policy interests of its Chairman, Vice President Hubert Humphrey (U.S. Congress, 1966). It was a consequence, as well, of the long history of executive leadership in the conduct of foreign policy, and the constitutional authority supporting that leadership.

Since the earliest days of the Republic the President has served as principal spokesman for the Nation's foreign policy; he can respond quickly to international crises, and his position embraces the clarity of responsibility and command of a single leader (Hamilton, 1788). The Consitituion, too, stipulates his foreign policy role.

> The President shall be Commander-in-Chief of the Army and Navy of the United States, and of the Militia of the several States, when called into the actual Service of the United States;...
>
> He shall have Power by and with the Advice and Consent of the Senate to make Treaties, provided two thirds of the Senators present concur; and he shall nominate, and by

> and with the Advice and Consent of the Senate, shall appoint Ambassadors...(1789).

The constitutional preeminence of the President in the field of foreign policy was solidified by the 1936 Curtiss-Wright Supreme Court case. In that decision the Court maintained that the President is empowered to enforce treaties, and that he is, in fact, the "sole organ" and "exclusive power" of the Federal government in international relations (U.S. Supreme Court, 1936).

If Congress had played a more significant role in the development of IDOE -- and we can only speculate on the matter -- it is likely that the program would have had a considerably different appearance than the one that emerged from the Council. A congressional formulation would have had different characteristics because Congress is geared to operate toward short-term, pragmatic payoffs. In addition, goals set by Congress are likely to reflect constituency relevant concerns (Mayhew, 1974;Miller and Stokes, 1963). Finally, if IDOE had been affected by statute instead of by executive order, the program would have assumed a different status in the bureaucracy and would be more heavily protected and controlled by Congress (Seidman, 1975: ch. 2).

But, Congress was not completely uninterested and uninvolved in IDOE's development. At a Hearing of the House Subcommittee on Oceanography in which a Concurrent Resolution in support of the Decade concept was being considered, the congressmen wanted to know whether the Resolution could be interpreted as "a legal endorsement for the executive to move into this International Decade of Ocean Exploration?" (U.S. Congress, House, 1968:205). They were concerned, because, as the Subcommittee Chairman, Congressman Lennon expressed "I found the other day that the Gulf of Tonkin Resolution, although it had been specifically said that it was not a declaration of war at the time the Congress approved it, yet has been held by the military courts that it was in fact a declaration of war..("U.S. Congress, House, 1968:205). The congressmen requested assurances in writing from the Bureau of the Budget that their action in support of the Decade should not be considered a "blank check". Although the Subcommittee requested no significant role in the development or implementation of IDOE, it was protecting its prerogative to oversee execution of the Decade (U.S. Congress, House, 1968:205-207).

Despite the obvious national interests at stake in the prevention of a new international ocean regime, the Council soon found itself embroiled in a time-consuming, internal bureaucratic debate around issues of agency jurisdiction, budgeting, and planning.

The Decade architects in the Council assumed that both their mandate and their lofty bureaucratic position in the Executive Office of the President gave them the authority and the power to impose a Decade program on the bureaucracy, extending across bureaucratic jurisdictional boundaries. As they were to discover, their assumptions were wrong. One of the first lessons learned by Presidents and their Executive Office personnel is the immense frustration of working with the bureaucracy (Neustadt, 1960). Harry Truman once remarked during his lame-duck Presidency that President-elect Eisenhower would find giving orders in the Executive branch a different matter from giving them in the military. A President, he suggested, also had to be a good persuader. As stated by Seidman, "(u)nless a President is able to convince his departmental allies that they need him as much as he needs them, inevitably they will gravitate to another power base" (1975:82). President Nixon was so frustrated by bureaucratic inertia that upon his election to a second term he requested pro forma resignations from all top level administrators in his administration. He also attempted a vast, reorganization of the Executive branch to make the bureaucracy more responsive to Presidential leadership. Perhaps more than most Presidents, Nixon viewed the bureaucracy as the "bad guys" and described interactions with its elements as "guerrilla warfare".

The early operations of the Marine Sciences Council suggest that it was naive about the machinations of bureaucratic politics. It was absorbed in the activist style of its leader, Vice President Hubert Humphrey. According to the Executive Secretary of the Council we were "(w)ell aware of the limited success of interagency mechanisms for coordination much less for government-wide inspiration, (yet) we were confident that this vice-presidentially geared instrument could do it" (Wenk, 1972:104).

In the opinion of the Council leadership, the high level membership of the body, -- the Secretaries of the Executive Departments responsible for marine affairs, the Chairman of the Atomic Energy Commission, the Director of the National Science Foundation, and the Vice President as Chairman, -- could overcome, through rational discussion, interagency rivalries that historically plague interagency coordinating mechanisms. But what the Council failed to recognize was that:

> Generally, the (department heads) must adapt to the institution, rather than the institution to them. There are likely to be daily reminders that they are merely temporary custodians and spokesmen for organizations with distinct and multi-dimensional personalities and deeply ingrained cultures and sub-cultures reflecting institutional history, ideology, values, symbols, folklore, professional biases, behavior patterns, heroes, and enemies. A department head's individual style must not do violence to the institutional mystique, and the words he speaks and the positions he advocates cannot ignore the precedents recorded in the departmental archives. Most department heads are free only to be as big men as the President, the bureaucracy, the Congress, and their constituencies will allow them to be (Seidman, 1975:121-2).

Interagency disputes seemed to boil below a surface calm, but one by one they eventually rose to the top. Problems were raised by the Budget Bureau, the State Department, the National Marine Fisheries Service, and the National Science Foundation. In the case of the Budget Bureau, it attempted to keep as many Presidential funding options open as possible. The State Department was concerned that the fisheries research and exploration components in the early Decade proposals would create problems relating to international fishing agreements and treaties. The Bureau of Commercial Fisheries (later the National Marine Fisheries Service) was wary of IDOE efforts to impinge on its bureaucratic responsibilities which were primarily in the area of fisheries and living resources. The National Science Foundation was hesitant about accommodating an administrative arrangement that did not comply with its own standard operating procedures, which relied heavily on external peer review and a basic science orientation.

These problems were resolved in Program Recommendations but the result was something less than a major success for the Council and the cause of interagency cooperation. Fisheries research and exploration were excluded from the program, funding prospects and expectations were clarified in the decision to request a block grant to NSF, and the planning, implementation, and management of the scientific components were left to the NSF to determine. Non-science components were to be administered by the project-relevant agencies with above-ceiling funding, but there was little hope that funds for these other areas would be forthcoming in the near future.

Support. Support for IDOE waxed and waned among the federal marine agencies and the basic marine science community as the program was molded, remolded, and eventually established in the bureaucracy. It never attracted much private industry involvement. In addition, neither the President nor Congress became actively involved in the development of the program.

Agency support for IDOE in its developmental stages rested heavily on whether or not the agencies felt threatened by the bureaucratic-imperialistic potential of IDOE, and whether or not they believed IDOE would cut into existing budgets. Once these matters were resolved in Program Recommendations, the agencies with marine responsibilities tended to support the endeavor universally. In addition, the National Science Foundation was skeptical at first about assuming management responsibility for the program, but when the agency was given the authority to plan, implement, and manage the program according to its own standard operating procedures, the reluctance receded.

The marine science community, too, wavered in its support of IDOE. At first the scientists considered the program to be a "political gimmick" manufactured by the Johnson administration to deal with foreign policy questions pertaining to the internationalization of the sea floor. They believed that the scientific community was being used as a pawn in a political chess game between the developed and underdeveloped nations (Vetter, 1978). When they were asked to participate in the planning of the Decade and to assume the leadership role in the planning process, they refused because of the conditions laid down by the government. According to the Council scheme, the scientists' members of the planning group -- a joint government/non-government planning mechanism -- would have had to become government employees responsible to the Council. This, they believed, would put them in a compromising position with their fellow scientists, and would further constitute an infringement on the autonomy of scientists to select and conduct their research free from government interference.

The scientists wanted to participate in the development of IDOE, but on their own terms. They were afforded the opportunity to participate when they persuaded the Marine Sciences Council that an independent study on the potential scientific content of an IDOE would be a useful first step in the planning process. Their report, An Oceanic Quest, became the basis for the scientific content of the IDOE program.

The differences between the Council Report, Program Recommendations, and the Scientists' report, An Oceanic Quest, were not notable, except for the deemphasis on fisheries and increased emphasis on pollution related research in the final Council recommendations. These changes were made to pacify bureaucratic interests in order to get the program to the President for his consideration. Both reports recommended a wide range of basic and applied research and survey work in the broad areas of environmental quality, environmental forecasting,and seabed assessment,on a national and international level, as well as programs for marine technology development and an improved system of national and international data exchange. The ultimate objective of both reports was to lead to a more thorough understanding of the ocean, it processes, and its resources for the benefit of mankind.

Another major point concerning scientific support for the Decade relates to the type of marine scientists interested in the program. Within the marine science community opinions ranged from hostility to indifference to support. As fashioned by the NAS-NAE Committee that wrote An Oceanic Quest, the Decade concept possessed a deep ocean bias. That is, most of the projects suggested for Decade consideration were studies of deep ocean phenomena. There was little to pacify the interests of scientists interested in near shore, coastal, and estuarine phenomena. Further, most of the scientific projects suggested in the Quest and Program Recommendations would require teamwork, long-term funding, and all the other trappings of large scale investigations; marine scientists were not accustomed to such an approach. There was extreme reluctance among some segments of the community -- particularly the older scientists already "well connected" with the federal funding network -- to depart from traditional small scale approaches.

The group to which the Decade concept appealed were the marine scientists at the large, research vessel supporting institutions. This community had the most to gain from support of the Decade. They possessed the capabilities and expertise for conducting Decade recommended projects. They also were in a position to recognize the need for large scale approaches to complex problems that were no longer amenable to the small scale mode of operation. (Survey findings elaborating on this finding and other characteristics of supportive scientists are reported in the next chapter).

Organizational Location.

> "The first organization decision is crucial. The course of institutional development may be set irrevocably by the initial choice of administrative agency and by the way in which the program is designed. Unless these choices are made with full awareness of (the) environmental and cultural influences (of the parent organization) the program may fail or its goals may be seriously distorted" (Seidman, 1975:158).

There does not appear from the record to have been much consideration of the organizational location of IDOE. NSF was deemed appropriate evidently because it had housed the planning apparatus for earlier international scientific endeavors, such as the International Geophysical Year and the International Indian Ocean Expedition, and because it would be administering the scientific component of the program.

The Foundation is an independent agency in the Executive branch. The President maintains a measure of control over the organization through his appointments of the Director and the National Science Board -- the Foundation's dual executive mechanism. Congress exercises some control as well in its yearly appropriation and authorization requirements. Effective operating control, however, is exercised by the academic basic science community. For example, although the President is empowered to appoint the Director and the board members with the advice and consent of the Senate, he would not think of submitting anyone's name without prior approval by the basic science community. In fact, in 1968 President Nixon even "conceded the right of the National Science Board to nominate the Director... although this was the very issue that caused President Truman to veto the original National Science Foundation Act" (Seidman, 1975:125). In addition, Congress does not possess the expertise to evaluate the Foundation appropriation request critically. Its control is exercised more effectively through its oversight of NSF programs. The congressional review of Mohole[a] and eventual cut-off of funds to that project is a good example of its oversight control (Greenberg, 1966:87-111). But even in its oversight role, Congress

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[a]Mohole was an attempt to drill a hole through the earth's crust to the mantle. It was perceived that access to the mantle would be easiest through the relatively thin crustal area in the ocean at the Mohoravicic discontinuity. But the effort was unsuccesstul and proved to be an administrative and scientific disaster.

rarely has an opportunity to take such dramatic action.

The organizational culture of the Foundation is infused with an academic, basic science ethos. The administrative structure is organized along disciplinary lines, and its administrative arrangements are based on meritocratic principles that advance the support of the most qualified applicants, with proposals that promise to advance their respective fields of research furthest into the frontiers of knowledge. The mission of the Foundation is to support science for its own sake -- the "best" science -- and is not directed toward any other objectives.

The administrative arrangements of the Foundation are based on "an elaborate superstructure of advisory arrangments" that give the scientists in the field - the peers of the applicants - "maximum influence over the allocation of funds" (Seidman, 1975:247). As one observer of the federal R&D system remarked, scientific research is the only pork barrel in which the pigs determine who gets the pork.

The charter revision of 1968 that authorized the Foundation to support applied research directed to national needs created some problems in NSF because of its potential impact on the established system of administrative arrangements and its appeal to a broader clientele. But the rhetoric and controversy that surrounded the new emphasis were greater than the actual effect. Basic research is still the principal interest of the Foundation; approximately 80 to 85 percent of its budget is directed to that area.

The Foundation does not support any oceanographic research that could be classified as applied, or directed at national needs, although IDOE's stated purpose implies an applied or directed emphasis. As described in one planning document, the principal objective of IDOE was:

> To increase knowledge of the ocean, its contents and the contents of its subsoil, and its interfaces with the land, the atmosphere, and the ocean floor and to improve understanding of processes operating in or affecting the marine environment, with the goal of enhanced utilization of the ocean and its resources for the benefit of mankind (UNESCO, 1970:7).

The NSF-funded component of the IDOE, which was the only funded component then and in later years, was directed to concentrate on the substantive areas mentioned above, emphasizing basic science research that would ultimately lead to benefits for mankind. NSF was never asked to concentrate on any of the applied scientific and exploration goals of the Decade, nor did it receive funds to do so. In this role NSF felt entirely comfortable.

CHAPTER III

PROGRAM INITIATION: ORGANIZATIONAL, ADMINISTRATIVE, AND CLIENTELE POLICY INFLUENCES

INTRODUCTION

Although pre-organizational factors are critical to an understanding of eventual policy decisions and patterns of organizational behavior, they are not determinant. The organizational environment of a new program, its administrative arrangements, and its clientele influences also have an impact. The following chapter describes these factors and analyzes their significance for the IDOE policy process.

CONTINUED PLANNING

Before undertaking the principal task of the chapter, however, additional historical information relating to the planning of IDOE will be reviewed to continue the course of events outlined in the last chapter, and to shed additional light on the factors influencing IDOE policy.

The IDOE concept became a reality on October 19, 1969, when Vice President Spiro Agnew, as Chairman of the Marine Sciences Council, announced the Administration's intention to develop IDOE as one of several marine initiatives. On November 7, 1969 Agnew designated the National Science

Foundation as lead agency, giving it planning, implementation, and management responsibilities. At that time he requested that the Foundation prepare a report to the Council for its January meeting outlining the plans and prospects of the Decade. The subsequent report "described consultation by NSF with agency representatives and an ad hoc advisory committee to identify research objectives and policy for the initial year of the Decade (FY 1971), and stated perliminary (sic) plans for coordination with international activities underway" (NSF, 1970, attachment 2:3).

But between January 1970 and March of that year progress slowed. In fact, the IDOE Office itself was not established until March. At that time, Dr. J. L. McHugh, formerly Acting Director of the Office of Marine Resources in the Department of Commerce, was appointed IDOE Head. For the next several months he and an assistant, Mr. John R. Twiss, Jr., worked alone to develop an organization and a plan for scientific support. By June the Foundation was able to report the following progress.

> 1. Established an IDOE Office and recruited an outstanding scientist to direct it;
>
> 2. Developed, with the assistance of an outstanding ad hoc panel of consultants, program rationale as the basis for detailed program planning;
>
> 3. Prepared a notice describing program objectives and criteria for their selection to be sent to the scientific and industrial community to solicit appropriate proposals from them;

> 4. Established effective working participation in the various national and international coordinating and planning communities with major interest and objectives; and
>
> 5. Most recently recruited an outstanding advisory panel...(NSF, 1970, attachment 2:1-2).

Reaction in the Foundation to the rate of IDOE progress was negative. Despite the delay in the IDOE appropriation, NSF officials did not feel that the program was ready to be implemented should the funds become available (Owen, 1978).

Part of the problem rested with the fact that Dr. McHugh was waiting to take over a new position as Professor of Marine Resources in the State University of New York (SUNY) at Stony Brook the following September. While the SUNY position had not yet been offered to him when he assumed the IDOE Head, it became available shortly afterwards. He resigned the IDOE job effective September 1, 1970 (McHugh, 1978; NSF, 1970:1).

The slow progress at IDOE went largely overlooked at the next echelon of the Foundation because that position, too, was in a state of flux. In October 1969 the Foundation had undergone a major reorganization. Four presidentially appointed assistant directors were to administer the four new directorates in the restructured framework. Unfortunately, for IDOE and the other programs in its directorate, the assistant director position to which they were to report was filled on a temporary basis. Not until June 1970 was an Assistant Director for National and International Programs appointed (NSF, 1974:79-83; Owen, 1978).

Upon the arrival of Dr. Thomas Owen in June, steps were taken to speed Decade planning in preparation for congressional testimony later that summer. Owen, with McHugh, brought in three oceanographers -- Dr. Worth Nowlin of Texas A&M University, Dr. John Ryther of the Woods Hole Oceanographic Institution, and Dr. Tjeerd van Andel of Oregon State University -- as consultants to develop a scientific program and an organizational plan for the office, as recommended by the newly established NSF-IDOE Policy Advisory Panel* (NSF, 1970, attachment 3:1; Owen, 1978).

The three consultants met with McHugh and Twiss for the first time in July. As the agenda indicates, they wasted no time getting to the heart of their responsibilities.

(1) to delineate emphasis areas for IDOE;

(2) to define the constituent elements of an IDOE proposal;

(3) to prepare guidelines for IDOE proposal submission;

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*The panel was composed of fifteen distinguished ndividuals, recruited from Government agencies, universities, research institutions, and private industries with marine interests. Their responsibility was to advise "NSF on matters of broad scientific program policy, on academic-institutional versus federal agency balance, and on the broad subject matter and geographic areas of interest: (NSF, 1970, attachment 3:3).

(4) to help resolve the question of a national research ship policy;

(5) to work out evaluation procedures for funding proposals from academe, industry, and federal agencies;

(6) to suggest candidates for an IDOE staff;

(7) to define the role of the consultants during the ensuing six months;

(8) to arrive at tentative budgets for FY 1972 and FY 1973;

(9) to define the ground rules for interactions with other federal agencies;

(10) to discuss the kind of industrial representation that would be appropriate for the staff and advisory panel (Nowlin and Jennings, 1978).

At subsequent meetings of the group McHugh was not present, and shortly thereafter he left IDOE for the position at SUNY. But by then the consulting triumvirate had assumed management control anyway, leaving the day-to-day administrative responsibilities to John Twiss.

Throughout the Summer of 1970 the consultants proceeded to define the nature of the scientific programs to be supported by IDOE, sent letters to institutions that might be interested in pursuing IDOE research support, and developed guidelines and suggestions for research proposals (NSF, 1970b; NSF, 1970c). They worked on developing a management scheme, and a general *modus operandi*. They even reviewed the proposals that had already come into the IDOE Office and made plans for the first allocation of grants.

Looking ahead to McHugh's departure, Owen and the consultant team undertook the task of locating a new Head. Several prominent oceanographers including Dr. Warren Wooster and Dr. William Menard were offered the post, but declined. Attention then turned to Mr. Feenan Jennings, Deputy Director and Senior Oceanographer at ONR's Ocean Science and Technology Division. Jennings' name was floated among the directors of the major oceanographic institutions and was favorably received. On the basis of their recommendations and that of Dr. Nowlin, also formerly of ONR, Jennings was offered the position. He accepted the offer on August 16, 1970, and moved into his new position on October 1, 1970 (Nowlin and Jennings, 1978; Jackson, 1970:9).

IDOE still had not received its FY 1971 appropriation when Jennings arrived. It had been tied to a Housing and Urban Development bill which President Nixon had vetoed (Jackson, 1970:9). The first year funds of $15 million finally reached IDOE in November. It was disbursed almost immediately to several research projects that had been reviewed and promised support. (The process of proposal review will be described in the "Administrative Arrangements" section of this chapter).

ORGANIZATION

International Decade of Ocean Exploration. Jennings' first task was to develop an organizational framework and staff it fully. His job was made easier, though, by the planning of the consultants, which provided for three programs to support scientific research in the areas of Environmental Quality (EQ), Environmental Forecasting (EF), and Seabed Assessment (SA). The EQ program as originally planned, was funded to support studies on the quantity and distribution of chemical elements in the oceans and their damage to marine organisms; EF was to support projects that would increase knowledge of ocean dynamics and lead to improved environmental forecasting; and SA was to support investigations on the geological structures, sedimentary distributions, and dynamic properties of the ocean floor (NSF, 1973, attachment 3:1,9, and 14).

When Jennings came on-board in October he proceeded to staff the office with regular, full-time personnel, and fill out the organization structure. As related by Jennings, there was nothing mysterious about how he recruited his staff. Offers were made to individuals that he knew personally, or to individuals who were recommended to him by others he knew and respected, and who possessed demonstrated scientific and/or administrative abilities for overseeing the large scale type of science that IDOE was to support. He brought in academic scientists and science administrators from ONR primarily, although many individuals had experience in private industry as well (Jennings, 1977; 1978).

TABLE 2

IDOE STAFF PREVIOUS
WORK EXPERIENCE
BY SECTOR[a]

Sector	Number
Academic	20
Private Industry	10
Other Federal Agency	7

[a]IDOE has employed 22 individuals at the Assistant Program Manager level or higher since its initiation, but many have had experience in 2 or 3 sectors.

Source: Telephone conversation with Dr. Bruce Malfait, Acting Head of IDOE, January 3, 1978.

Jennings created separate program offices for each of the programs -- EQ, EF, and SA -- and allowed for their staffing by a program manager and an assistant program manager who would share administrative responsibilities along project lines. He also established two staff positions including a Special Assistant for International Affairs and a Special Assistant for Technology and Engineering, and a line position of Deputy Head.

The function of the Special Assistant for International Affairs was to act as a liaison and information conduit to and from the intergovernmental organizations and international scientific organizations, and ultimately "pave the way for Jennings' appearances before the U.N.'s IOC[a] to announce American contributions to LEPOR[b]" (Nowlin and Jennings, 1978). The Special Assistant for Technology and Engineering was to perform a similar function between IDOE and private industry. It was the job of the Deputy Head to oversee the day-to-day operation of the program offices so that Jennings could "keep an eye on the administrative infighting going on in the Foundation" (Nowlin and Jennings, 1978).

The organizational structure described above has endured throughout IDOE's history with two exceptions. First, a fourth program office was added in 1971 in the area of Living Resources. It was created to fund research

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[a](IOC) Intergovernmental Oceanographic Commission.
[b](LEPOR) Long Term and Expanded Program of Oceanographic Research.

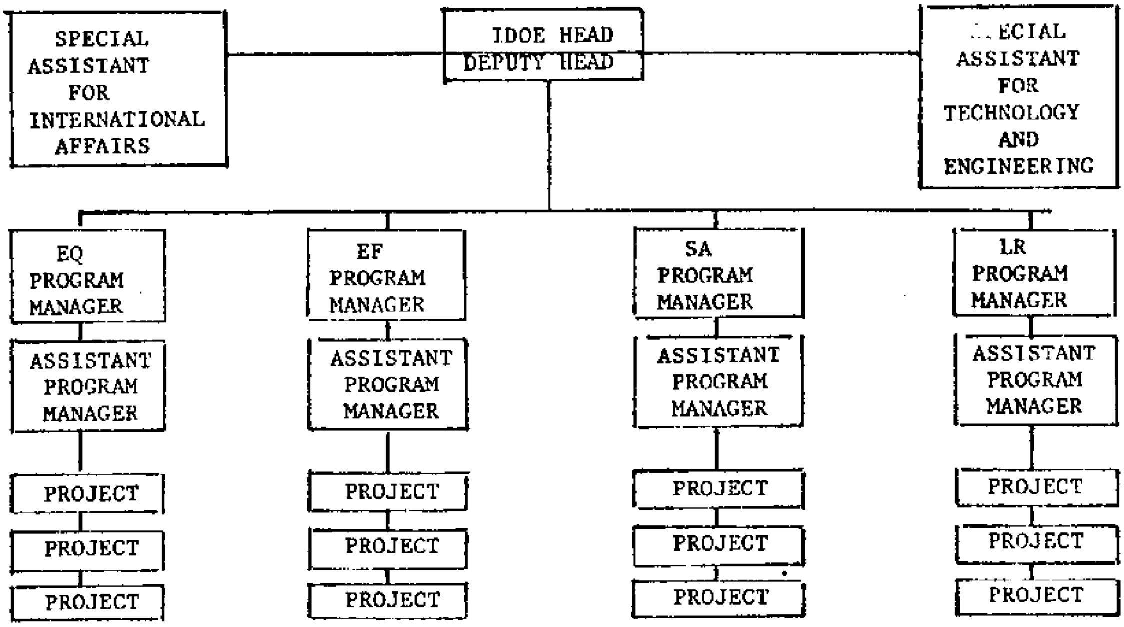

FIGURE 7. IDOE ORGANIZATIONAL STRUCTURE

Source: Adapted from the organization chart depicted in National Science Foundation, International Decade of Ocean Exploration, Washington, D.C. Government Printing Office. October 1971:3 (NSF 71-34) that would "provide a scientific foundation for better management and use of the ocean's biological resources" (NSF, 1973b:24). Second, the position of Special Assistant for Technology and Engineering has remained unfilled since the first year largely because of the incompatibility of IDOE program directions, which were heavily basic science oriented, and private industry interests (Nowlin and Jennings, 1978).

National Science Foundation. Within the Foundation's organizational scheme IDOE was originally created as an Office in the Directorate for National and International Programs (NI), The office designation meant that IDOE reported directly to the Assistant Director for National and International Programs, a level at which crucial budget and program decisions were made.

The NI Programs Directorate itself was established only in 1969. The responsibilities of the NI Programs Directorate included overseeing the administration of several offices, among which were the marine related Sea Grant, Polar Programs, Ocean Sediment Coring Program, and the Oceanographic Facilities and Operations Program. It also had management authority over several non-marine related offices. All the offices in the NI Directorate had one or more of the following characteristics:

- Significant operational content;
- Major logistic requirement;

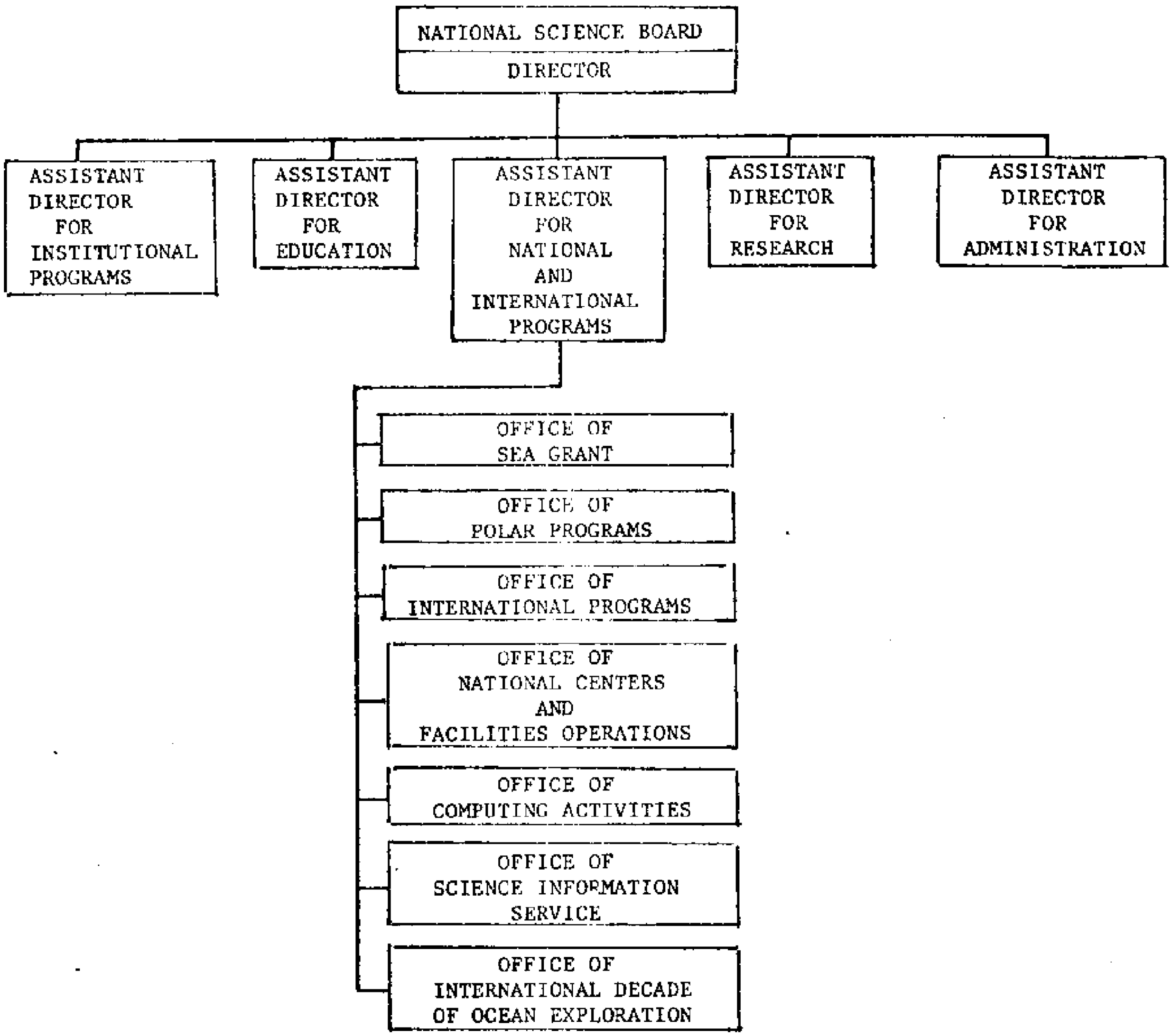

FIGURE 8. NSF ORGANIZATIONAL STRUCTURE SELECTED PROGRAMS, 1971

Source: Adapted from the organization chart depicted [illegible] Science Foundation, Organizational Development of The National Science Foun[illegible]ion, Washington, D.C., Government Printing Office, 1974. Chart 21.

- substantive and continuing international involvement;
- facilities for joint use of academic investigators;
- coordinated and continuing science information activity;
- major computer science involvement (Owen, 1971).

In 1975 the Foundation underwent another major reorganization that affected IDOE and most of the Foundation's other marine science programs. At that time the NI Programs Directorate was abolished and its program responsibilities were transferred to several newly created directorates constructed along academic discipline lines. IDOE was placed in the new Directorate for Astronomical, Atmospheric, Earth, and Ocean Sciences (AAEO) -- one of three basic science research directorates. Most importantly it was reduced in status from an Office to a Section. Offices were replaced by divisions and sections were placed under division level authority. IDOE became one of three sections in the newly created Division of Ocean Sciences (OS) in the AAEO Directorate. IDOE retained the title of Office and several other office level prerogatives until the new division director was appointed.

The new OS Division brought together most of the ocean related research including the small scale support Oceanography Section and the Office for Oceanographic Facilities and Support. Still outside the OS Division was the Ocean

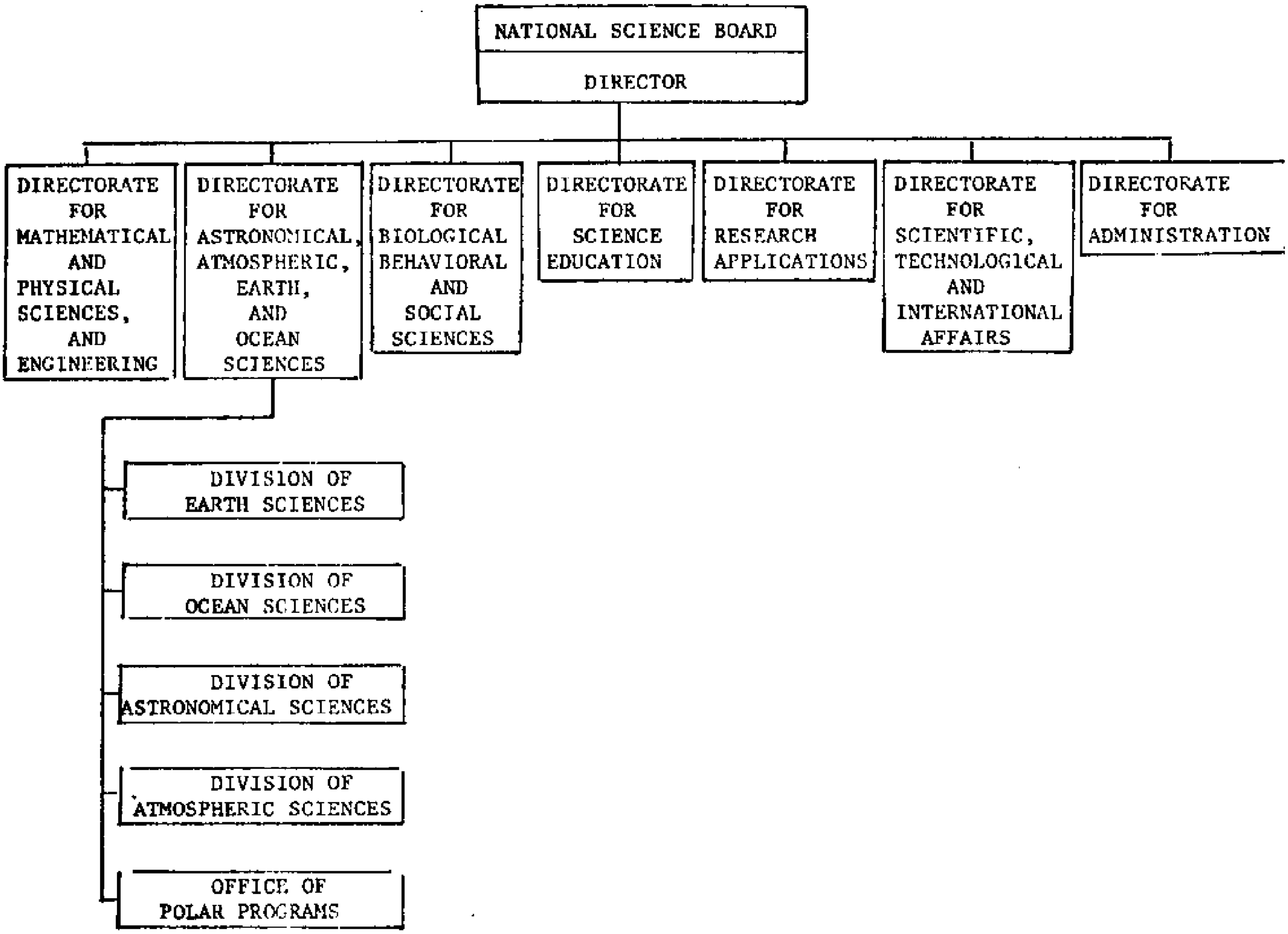

FIGURE 9. NSF ORGANIZATIONAL STRUCTURE SELECTED PROGRAMS, 1975

Source: Adapted from the organiztion chart depicted in National Science Foundation, Organizational Development of the National Science Foundation, Washington, D.C., Government Printing Office. 1974. Chart 27.

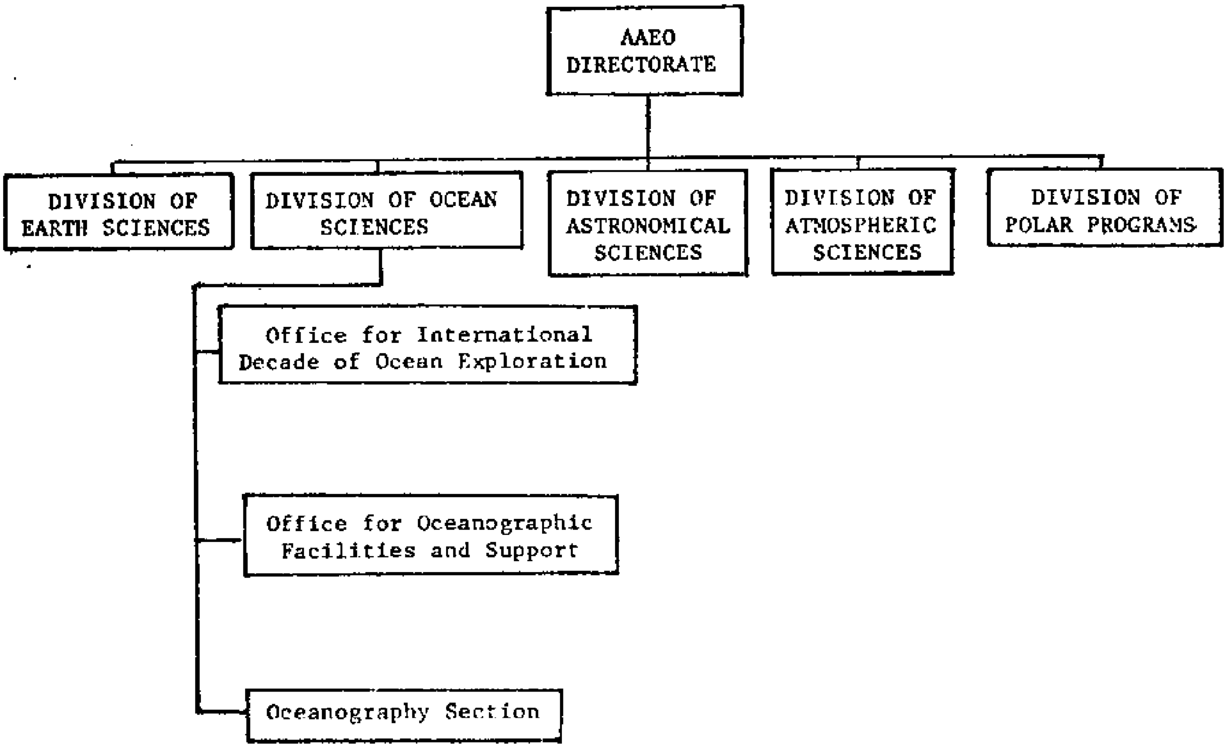

FIGURE 10. ORGANIZATIONAL STRUCTURE OF THE DIRECTORATE FOR ASTRONOMICAL, ATMOSPHERIC, EARTH, AND OCEAN SCIENCES, SELECTED PROGRAMS, 1975

Source: Adapted from the organization chart depicted in National Science Foundation, Organization Directory, Summar 1978, Washington, D.C., Government Printing Office. 1978. 10-11.

Sediment Coring Program which constituted the major part of the Earth Sciences Division in the AAEO Directorate, and the polar oceanographic research which was located in the new Division of Polar Programs, also in the AAEO Directorate.

Funding. Within IDOE the four program offices have been funded at significantly different levels, reflecting varying amounts of proposal pressure, NSF-IDOE scientific priorities, and the experimental requirements of the projects themselves. The higher funding levels of the Environmental Forecasting and Environmental Quality programs are the result of all three factors. The MODE project and the GEOSECS project, for example, were both theoretically mature projects awaiting an appropriate funding source when the IDOE Office was initiated. In addition, both met IDOE's intention to support excellent quality science in areas of national need. Finally, MODE and GEOSECS both required extensive, long term field components, which has been a pattern for EF and EQ projects, unlike those in SA and LR.

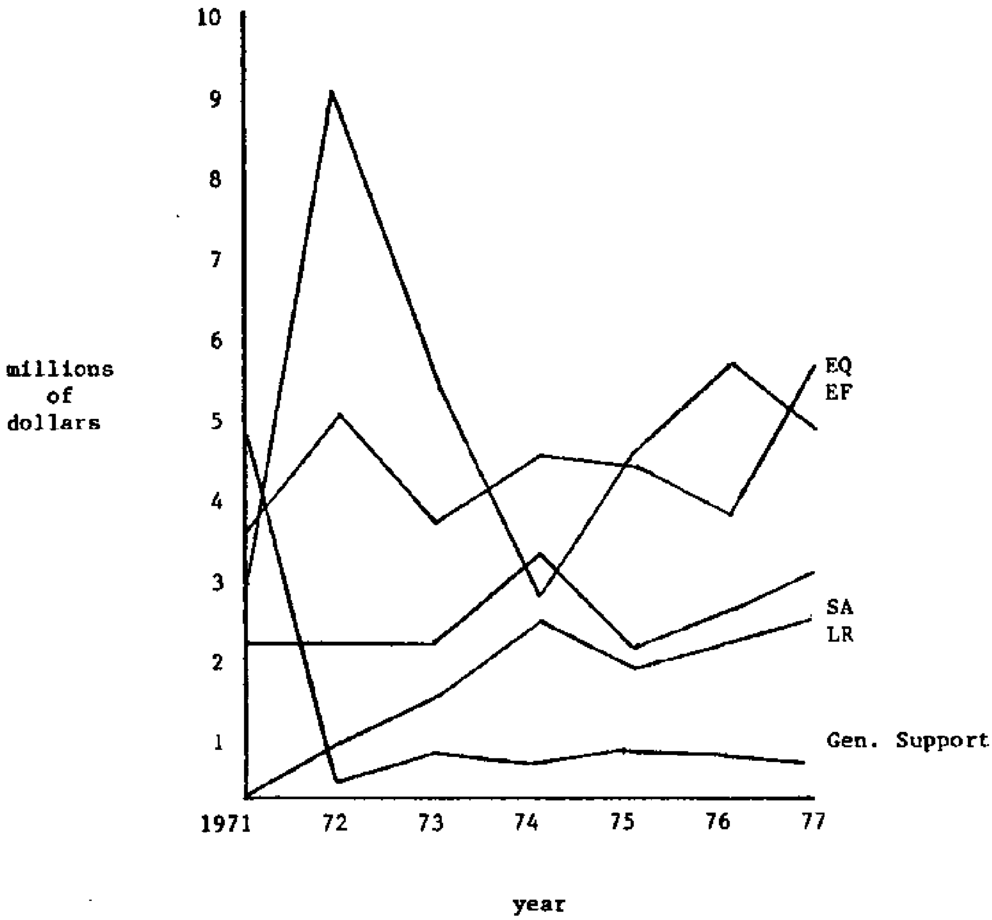

FIGURE 11. ACTUAL IDOE PROGRAM OFFICE FUNDING AWARDS, 1971-1977
(ship support not included) (in millions)

The Foundation authorities have not markedly altered the IDOE budget since its inception. Although IDOE's arrested $15 million budgets have disappointed its supporters, IDOE has not fared badly in comparison to other programs in its directorate through the years. Its budget increased from 1971 to 1974, similar to most of the other programs in the National and International Programs Directorate. In subsequent years the IDOE budget fluctuated much like the overall AAEO Directorate budget.

The National and International Programs Directorate, however, did not fare as well in terms of budget increases as the Research Directorate. From 1971 to 1972 the NI Directorate budget increased by 72 percent, but that was largely due to an influx of support for the U.S. Antarctic Research Program. Otherwise its budget increase was 10 percent smaller than the 42 percent increase in the Research Directorate budget. In 1973 the NI Directorate budget increase was only 2.8 percent compared to 7.8 percent for the Research Directorate. In 1974 and 1975 the NI Directorate budget actually declined by 14.1 percent and 4.6 percent respectively, while the research budget increased 4.8 percent and 20.3 percent over the same period.

In 1975 the Foundation was reorganized and the large scale programs of the NI Directorate were scattered among the several new directorates. Many large scale programs including the oceanographic ones were transferred to the new Astronomical, Atmospheric, Earth, and Ocean Sciences Directorate. In fact, "almost 60 percent of AAEO's budget is devoted to long term commitments to the National Research Centers in Astronomy and Atmospheric Sciences, Oceanography's academic research fleet, the Global Atmospheric Research Program, and the International Decade of Ocean Exploration" (Slaughter, 1978:6). From 1976 to 1977 the AAEO Directorate budget increased less than any of the other basic research program directorates. The AAEO Directorate budget increased 6.4 percent, but the Biological, Behavioral, and Social Sciences budget increased 16.1 percent and the Mathematical, Physical Sciences, and Engineering budget increased 16.7 percent. The applied research segment of NSF, Research Applied to National Needs (RANN), and later renamed Applied Science and Research Applications (ASRA), fared worst by declining 11.5 percent from its 1976 budget. Between 1977 and 1979 the AAEO Directorate fared better than the other directorates, but the budget request for 1980 again recommends a smaller increase; only the ASRA Directorate fares worse.

IDOE and AAEO budget growth has trailed behind the growth in other NSF areas probably because of the Foundation's indisposition toward the large scale mode of operation. As explained at considerable length below. NSF has developed administrative procedures and a cultural mind-set that are best suited to the support of small scale projects.

Compared to the expansion of the Total Federal Marine Science Program and the growth in the oceanographic research component the, IDOE fares poorly. Thus, outside the Foundation IDOE represents a declining percentage of the total federal effort in this area. Except for the significant increase in funding from 1971 to 1972, IDOE has fallen consistently further behind the growth of the Total Federal Marine Science Program, and the federal oceanographic research component.

ADMINISTRATIVE ARRANGEMENTS

Goals. The Vice President outlined six goals for Decade consideration in his October 19, 1969 speech announcing the Decade. They were:

> (1) Preserve the ocean environment by accelerating scientific observations of the natural state of the ocean and its interactions with the coastal margin -- to provide a basis for (a) assessing and predicting man-induced and natural modifications of the character of the oceans; (b) identifying damaging or irreversible effects of waste disposal at sea; and (c) comprehending the interaction of various levels of marine life to permit steps to prevent depletion or ex inction of valuable species as a result of man's activities;
>
> (2) Improve environmental forecasting to help reduce hazards to life and property and permit more efficient use of marine resources -- by improving physical mathematical models of the ocean and atmosphere which will provide the basis for increased accuracy, timeliness, and geographic precision of environmental forecasts;

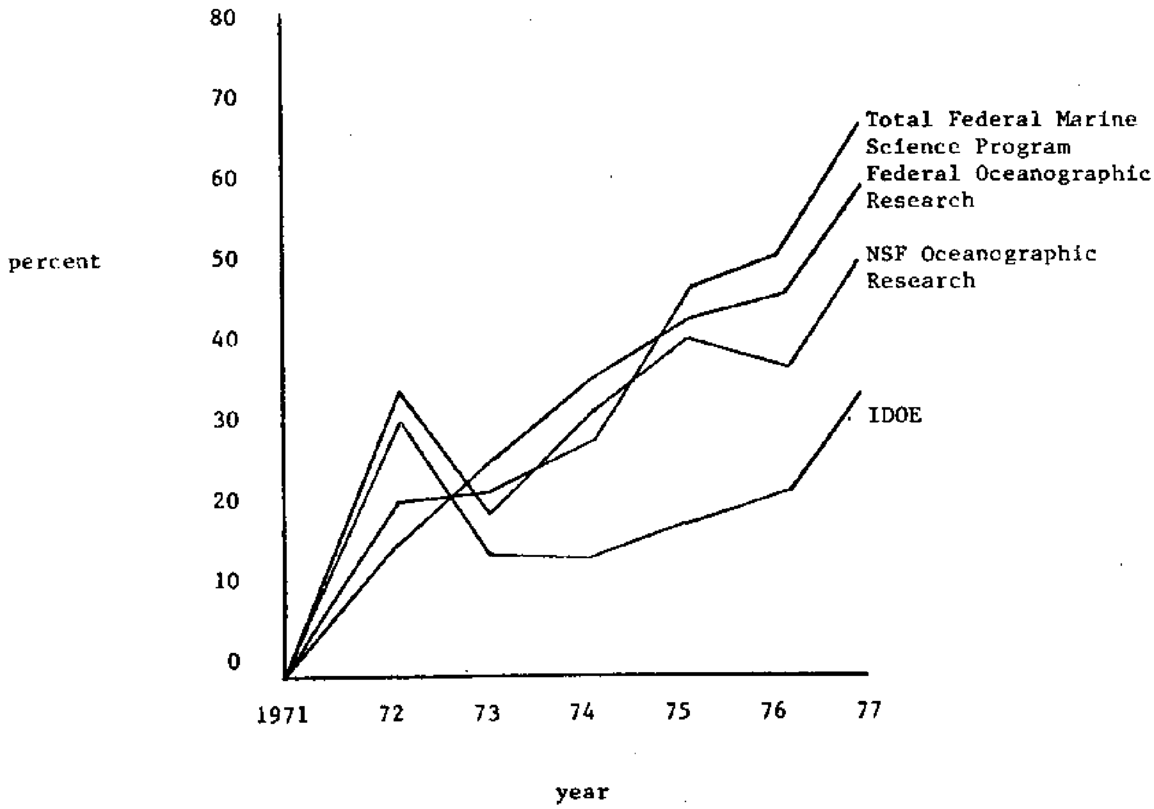

FIGURE 12. CUMULATIVE PERCENT INCREASE/DECREASE IN COMPONENTS OF THE FEDERAL MARINE SCIENCE PROGRAM, 1971-1977

(3) Expand seabed assessment activities to permit better management -- domestically and internationally -- of marine mineral exploration and exploitation by acquiring needed knowledge of seabed topography, structure, physical and dynamic properties, and resource potential, and to assist industry in planning more detailed investigations;

(4) Develop an ocean monitoring system to facilitate prediction of oceanographic and atmospheric conditions -- through design and deployment of oceanographic data buoys and other remote sensing platforms;

(5) Improve worldwide data exchange through modernizing and standardizing national and international marine data collection, processing, and distribution; and

(6) Accelerate Decade planning to increase opportunities for international sharing of responsibilities and costs for ocean exploration, and to assure better use of limited exploration capabilities (Marine Sciences Council, 1970: 195-196).

Limited funding, agencies' jurisdictional problems, and bureaucratic cultural factors within the Foundation, however, constrained IDOE from carrying out the program in its broad scope. Instead, the IDOE office refined an operating philosophy for the conduct of the program and identified a limited number of specific research problems upon which to focus attention. Scientific projects were avoided that duplicated the responsibilities or the "prerogatives" of other federal agencies, or which were contrary to the predominant basic science orientation of the Foundation, and particularly its marine programs. Instead, basic science projects were selected that fitted broadly within the scientific objectives of the program, were theoretically mature for investigation, and were amenable to a large scale approach. In addition, the support objectives calling for an environmental monitoring system, improved data exchange, and international sharing of exploration responsibilities were each interpreted narrowly and defined to apply only to the specific research projects supported by the Decade (Jennings, 1971:8).

Program Emphasis. The four IDOE programmatic themes -- environmental quality, environmental forecasting, seabed assessment, and living resources -- were developed in several scientific and governmental planning documents (Marine Sciences Council, 1968 and 1969; NAS-NAE, 1969; UNESCO, 1970). The fledgling agency utilized these documents as a starting point from which to construct a viable scientific research program. As described above, potential agency jurisdictional problems, limited funding, and bureaucratic cultural constraints somewhat restricted IDOE program development. But, overall, the scientific and governmental reports served as the basis for the research effort.

The scientific emphases within the four programs have not altered significantly over the course of the Decade. The 1978 IDOE Progress Report defined the objectives of the four program offices:

> Environmental Quality -- to provide information on the quality of the marine environment and to assess and predict man's impact on the oceans through research on geochemical processes and marine pollution.
>
> Environmental Forecasting -- to explain the large-scale, long-term behavior of the ocean and the ocean's influence on weather and climate.
>
> Seabed Assessment -- to provide understanding of the geological processes along continental margins, midocean ridges, and deep-sea basins.
>
> Living Resources -- to provide scientific knowledge for improved management and use of the ocean's living resources. (NSF, 1978: 1, 21, 54, 69).

The definitions of program objectives are not significantly different than those outlined in planning reports published almost ten years earlier.

Within the broadly stated objectives of the IDOE, however, a wide range of basic and applied investigations are conceivable. In fact, an early IDOE Progress Report to the Marine Sciences Council recognized basic and applied responsibilities as part of its mandate.

> The IDOE was proposed by our Government to bring the best U.S. scientific talent to bear on the problem of acquiring basic and applied scientific knowledge needed over the long haul as the basis for continuing management policy decisions. NSF, as lead agency, has been vigorously involved in taking those steps necessary to accomplish this objective. (NSF, 1970, attachment 2:1).

Later IDOE reports moved away from the emphasis on basic and applied studies. Once money started flowing through IDOE to the scientific community a heavily basic science orientation was established. In contrast to the early IDOE statement, a post-IDOE planning report published in 1978 states: "The post-IDOE program should consist of projects of fundamental nature rather than of those directly tied to short term applications which would be more properly funded by other agencies" (NAS, 1978:93). It was not proposed as a change in emphasis, but only as a reaffirmation of existing policies.

The nature of IDOE scientific problems has required a large scale approach to their solution. This necessity was recognized in the earliest planning documents and was eventually built into the program (NAS-NAE, 1969:9). All research proposals to IDOE must include a statement demonstrating why the problem requires a large scale approach, the extent of cooperation required in the research and the anticipated benefits of the project that make it greater than the sum of its individual parts. Although the average grant to IDOE supported scientists has dropped precipitously since its early years from almost $300,000 to approximately $90,000, the IDOE maintains that the reduction is due to the purchase of equipment in the early years that remains extant today and does not need to be built into the proposals again (Jennings, 1978). In addition, IDOE grants still average more than twice the size of the small scale investigations funded by the Oceanography section (NSF, 1978b:C-IV-II and C-IV-17).

Preparation of Proposals. Proposal preparation for IDOE-type large scale projects is significantly more complicated than for small scale ones. Many pre-proposal hurdles must be jumped before the actual proposal may be written and submitted. In addition, in order to assure proposal coherence, its preparation requires a great deal of coordination among principal investigators (PI's).

The process usually begins with an informal discussion with an IDOE program manager or a letter which "should present the scientific problem and research objectives, methods, principal scientists, general budget levels, project management structure, areas of international cooperation, and relevance and significance of the project to the IDOE Program" (NSF, 1972).

If the IDOE staff suggests that the project is competitive the group is encouraged to write a preliminary proposal, or in some cases to develop a workshop that may bring other interested scientists into the project. Workshops are also convened when a scientific problem appears promising but the ongoing scientific work in the area needs to be brought together for a clearer understanding. The workshop may lead to a preliminary proposal.

The information contained in a preliminary proposal is not significantly different than that in the initial letter but it is a more extensive treatment of the issues. If the preliminary proposal is reviewed favorably by the IDOE staff (recently changed to independent scientists' review) the scientists may be encouraged to proceed with development of a final proposal.

The final proposal is actually a collection of proposals submitted by all the prospective PI's regarding their particular aspects of the larger project, including individual budgets for the first two years. The disparate individual proposals are tied together by an omnibus statement on overall project goals, the relevance of the project to IDOE objectives, a detailed management plan, requirements for ship time and engineering development, international implications, a detailed budget for the first two years and an estimated cost for the project into its final stages, and a schedule for reporting project progress (NSF, 1972).

Guidelines for Evaluation. IDOE proposals may be submitted from academia, private industry, the federal marine agencies, or any other sector. Every proposal is evaluated or reviewed on the same six criteria, which are:

1. The quality of the proposed research must be excellent.

2. A well-conceived management plan must be agreed upon. It must provide for strong scientific leadership, sound administration,

appropriate logistics support, and adequate means for project renewal or expansion, if desirable.

3. The research must not be duplicative of the efforts of other organizations.

4. Projects should be oriented toward the deep sea or the seaward portion of the continental shelf. However, it is recognized that in some instances it is necessary to collect data on land or in coastal areas. Examples would be the identification of terrestrial sources of pollutants and the collection of cores from Pleistocene seas.

5. Research components of a project must be complementary and essential to the primary goals of the entire project. Thus, the total project results should be greater than would be the sum of the individual parts if done separately.

6. The importance of the project to the goals of the IDOE must be clearly demonstrated (NSF, 1972).

In effect, the guidelines best suit academic, basic science oriented investigations. The criterion for excellent scientific quality proposals and the likelihood that the proposals will be reviewed by academic scientists makes it particularly difficult for scientists from other sectors to break in. In fact, nearly all IDOE proposals emanate from academe.

Evaluation Procedures. New and continuing proposals are reviewed in at least two of three ways:

1. mail review by recognized authorities in the field;

2. review by special ad hoc project review committees;

3. review by the IDOE staff. (NSF, 1972)

In most cases, IDOE proposals are mailed to several experts in the various research areas relevant to the proposed investigation. Reviewers are requested to read sections of the proposal closest to their own areas of expertise, but the entire proposal is usually enclosed, so that they can familiarize themselves with the broad scope of the research and obtain a better perspective on the section for which they are responsible.

The special ad hoc project review committees are composed of several persons nominated by the Director of the Division of Ocean Sciences and appointed by the Assistant Director for the Directorate of Astronomic, Atmospheric, Earth and Ocean Sciences, in consultation with the Foundation Director (NSF, 1977:1-2). The committee members are selected specifically to review a particular project in a research area in which they are considered expert. They are recruited for the tenure of the project.

The special ad hoc project review committees are a recently developed mechanism for reviewing proposals. Prior to their establishment the review procedure was done by a standing IDOE-wide Proposal Review Panel. Membership on the Proposal Review Panel was for one year with one additional one year extension possible. Special committees came into being when it was recognized that the projects and the review process would benefit from more continuity in the system (Mitchell and Collins, 1978).

The IDOE staff also conducts its own reviews of the projects. Staff reviews include the office head, the program manager with authority over the prospective project and any staff members with related interests.

The review process usually requires nine months, approximately the same amount of time used for reviews of small scale investigation proposals.

If a project is favorably reviewed by the IDOE review mechanisms, if the funds are available, and if the IDOE Office wishes to support the project, then approval must also be obtained at the levels of assistant director, director, and in most cases the National Science Board because of the size of IDOE grants. Any grant that exceeds $500,000 during any one year or accumulates a total commitment of $2 million or more must be approved by the National Science Board (NSF, 1978c:iii).

Administration. The job of the IDOE manager is not done once the grant is awarded, as is the case in most other NSF sections. Large scale projects require continual oversight of their progress, direction, coordination, and costs. But, as in the case of small scale science administration at NSF, the program manager has no responsibility for the management of the science. Instead, the scientists must develop a management scheme to manage the program themselves -- a system they overwhelmingly prefer -- and have it approved in the evaluation process (NACOA, 1975:39-42). In a fundamental sense, therefore, the program manager's responsibility for large scale and small scale administration is not significantly different at NSF. Warren Wooster has referred to the IDOE system as an "extrapolation" of small scale NSF procedures (Wooster, 1978). (IDOE project management methods are discussed in the next chapter).

THE TYPICAL NSF SYSTEM IN CONSTRAST

IDOE program goals fall clearly within the Foundation's authorization to support basic and applied research, to advance international scientific cooperations, and to develop scientific methodologies and technologies (U.S. Congress, House, 1968). But, although NSF authorization extends to a wider range of responsibilities, the Foundation is primarily a support mechanism for fundamental or basic science that is not directed at any Federal mission. Approximately 80 percent of the total NSF budget will be expended on research support in 1979, and slightly more than 91 percent of the research support budget will go to finance basic scientific research.

The typical mode of support in most of the NSF research directorates is through the small scale project grant. Unlike IDOE, most NSF project grants are for small scale studies requiring only one or two principal investigators. Proposal preparation, therefore, is relatively straightforward, although it is just as time consuming for the individual investigator. As with IDOE, proposals are evaluated primarily on the basis of their scientific excellence. Unlike IDOE, they are not required to be in conformance with any program objectives, nor need they develop management schemes and timetables for progress, or any of the other "accountability" mechanisms required of the large-scale investigation proposals.

Small scale grant proposals at NSF are submitted to an evaluation process that is very similar to IDOE's,although there is no need for a special ad hoc project review committee since most small scale grants last only for one or two years. In addition, since most small scale grant proposals do not request anything near $500,000 for one year, or $2 million for the duration of the project, a National Science Board evaluation is not required. The average NSF grant is approximately $50,000.

Another minor difference between the "typical"small scale project and the large scale one is in the way in which they are administered. The small scale project is pretty much on its own once the grant is awarded. The program manager responsible for the project rarely has any communication with the small scale grant recipient until the end of the year when a progress report or final report is required.

CLIENTELE INFLUENCES

Political Activity. Marine scientists are deeply involved in the policy process through their participation in advisory mechanisms at all levels. When a scientist reviews a grant proposal he is contributing to the policy process in a rudimentary way by passing judgment on its quality and scientific directions. When he participates in a scientific review panel or planning committee he often makes the same evaluations on a programmatic level. Participation in a presidentially appointed scientific commission gives him an opportunity to have an impact on science policy on a national level.

But, each of these methods of governmental involvement is on an individual basis and reflects the views of the lone scientist primarily, although they may also reflect the attitudes of his institution, the opinions of a "school" or group within his field of science, or even the "national interest" as he perceives it. It is clear that "there is no tradition of collective political action within the marine science community, nor is there any autonomous organization capable of sheltering such activity" (King, 1972:2). Lauriston King posits three reasons for the dearth of group political development.

1. the professional character of the community;

2. the historical development of its institutions;

3. the absence of any threats to its fundamental interests (King, 1972:2).

Professionally,marine science is not a unified science. It is not a collection of facts, methods, and theories based on one or more paradigms in a field of knowledge (Kuhn, 1962). It is more accurately described as a constellation of theories, methods, and facts based on the paradigms of several fields of knowledge. In other words, it has no single intellectual focus, only a geographical one -- the ocean.

In addition, according to even the most inflated estimates of its size, the marine science community constitutes no more than 3,000 professionals, which is less than one percent of the American scientific establishment. Neither its intellectual fragmentation nor its size are encouraging for collective political action.

Most importantly in this regard, scientific norms suggest that scientists remain aloof from the pushing and hauling of interest politics; that they maintain an apolitical posture. It is a role that society also expects of them (King, 1972:1).

The marine science community also has a peculiar historical development distinguished by institutional rivalries and non-cooperativeness. Three of the major institutions in the field -- the Lamont Doherty Geological Observatory of Columbia University, the Scripps Institution of Oceanography of the University of California at San Diego, and the Woods Hole Oceanographic Institution --

developed particularly stressful relations in the period immediately after World War II because "(e)ach was headed by a strong leader in his field..." and "(e)ach built a scientifically prestigious department that inadvertently hatched as a personality cult - with internal loyalties expected, and received, from staff and students alike, and with a clear disdain for those in rival camps" (Wenk, 1972:38). This factor too, has discouraged collective action over the years, although with the establishment of JOIDES* there are signs that the most extreme forms of the rivalries are breaking down.

Finally, despite some random discontent about shifting funding priorities and evolving agency strengths, the marine science community has fared well in the federally dominated support system. In fact, as indicated in chapter 2, since the mid-1960's marine science has done better than most other areas of science in sustaining federal financial growth. The relative affluence of the marine science community is the third factor discouraging political initiative.

National Academy of Sciences. To the extent that any group or entity speaks for the marine science community it is the National Academy of Sciences, Ocean Sciences Board

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*JOIDES, Joint Oceanographic Institutions for Deep Earth Sampling

(NASOSB or OSB) formerly the Committee on Oceanography (NASCO) (ICO, 1963:17). The Board was created to serve several purposes. Its main function has been to focus "attention on the national needs of the marine sciences and advise federal agencies on how these needs may best be met" (Vetter, 1964:5). Other functions include serving as the U.S. National Committee for the Scientific Committee on Oceanic Research (SCOR), encouraging the exchange of information and the coordination of activities among marine scientists, and focusing attention on the broad national needs for oceanography (Vetter, 1964:5-7). Over the years, it has been argued, the Board has served these purposes well and "has acquired a degree of legitimacy and respectability from government officials and scientists that exists nowhere else for the oceanographic community" (King, 1972:3).

Its influence undoubtedly stems in part from its catalytic role in stimulating national concern and increased levels of federal support for marine science in the early 1960's through its publication of Oceanography 1960-1970 (NAS-NRC, 1959:vol. 1). Throughout the 1960's and 1970's the Board has kept the political-bureaucratic community in Washington, D.C. attuned to the interests and concerns of marine scientists. In 1967, for example, NASCO approached the Marine Sciences Council about the possibility of conducting a workshop and publishing a report on a new program idea that was circulating in the Executive branch -- the IDOE. The Committee wanted to make sure that the scientific component conformed with the interests of the marine science community. Their report, An Oceanic Quest, published in June 1969, "was very influential in what happened later ... NASCO was largely responsible for the character of IDOE" (Vetter, 1978). After IDOE was initiated several ad hoc planning and review committees published reports on the progress and directions of the program,and made recommendations with regard to its management and scientific content (NAS-NAE, 1970; 1972; 1973).

Membership in NASCO, and later the Ocean Sciences Board, has included 15 scientists selected on the basis of several criteria including institution size, institution location, and field of science, although members are not supposed to represent their institution or any other interest while on the Board. Rather, "they are individuals, acting collectively, in behalf of the Academy - Research Council and serving the national interest in their field" (Vetter, 1964:4).

Nevertheless, membership on the Board has tended to be skewed toward the bigger, more highly acclaimed oceanographic institutions. The interests represented on the Board also seem to be those of the major institutions. For example, agenda items for a 1978 OBS meeting conducted at the Scripps Institution for Oceanography included a report on a major investigation of the nature of the impact of the federal funding system on academic marine science, a discussion on post - IDOE planning, and a report on the future of deep sea drilling, all subjects of interest primarily to the "big players" (Vetter, 1978).

In short, the intellectual diversity and size of the marine science community, its peculiar pattern of historical development, and level of federal support, act to stifle political organization. The organization that best speaks for the oceanographic community, to the extent thay any organization can speak for people who are accustomed to speaking for themselves, is the Ocean Sciences Board of the National Academy of Sciences. But the Board addresses itself primarily to the major national and international issues and programs of which the IDOE is one.

Funding Recipients and All Others. By the nature of the research program -- large scale, deep ocean, international -- IDOE science attracts scientists who are affiliated with the major research vessel supporting institutions. According to the results of the University of Connecticut survey, almost 50 percent of the scientists from the major ship supporting institutions that were interviewed have received IDOE funding compared to only 20 percent of the scientists from the lesser institutions.

IDOE science also tends to attract scientists that are more highly "tied-into" the federal funding network, because of the broad scope and "cutting-edge" qualities of the questions investigated by IDOE scientists. Well over half (62.5%) the IDOE supported scientists have received grants and/or contracts from at least four federal agencies, whereas only 29.2% of the others have done so.

TABLE 3

NUMBER OF FEDERAL FUNDING
SOURCES BY IDOE FUNDEES
AND ALL OTHERS
(percent by column)

Number of Agencies	IDOE Fundees	Others
0	-	18.9
1	3.6	16.9
2	13.9	18.7
3	20.0	16.4
4	25.5	12.4
5 or more	37.0	16.8
No. of Respondents	(165)	(628)

Clearly, IDOE fundees are more closely "tied-into" the funding network than the marine science community generally. IDOE fundees are also selective in their choice of federal agency support. IDOE fundees tend to receive research support more often from ONR's Program 480 and NSF's Oceanography section. The correlations are .67[a] and .70[a] respectively. They are much less likely to have applied for or received support from the Energy Research and Development Administration (ERDA) (now the Department of Energy), the Environmental Protection Agency, (EPA) or the Bureau of Land Management (BLM) in the Interior Department.

[a]Gamma

The pattern of research support is also suggestive of the type of the research preferred by IDOE-type scientists. IDOE fundees prefer basic scientific investigations to those that have applied or directed emphases.

Only NSF, Oceanography Section fundees and ONR, Program 480 fundees demonstrate stronger basic science emphases.

TABLE 4

TYPE OF RESEARCH BY IDOE FUNDEES AND ALL OTHERS[a]

(percent by column)

Research Type	IDOE Fundees	Others
Basic	48.4	29.5
Basic and Applied	42.9	43.4
Applied	8.7	27.2
No. of Respondents	(161)	(606)

[a]"Would you characterize your current scholarship or research as basic, applied or a mixture of both"?

The above characteristics -- institutional affiliation, relation to the federal funding network, and research orientation distinguish IDOE fundees from other marine scientists as well as any three characteristics. When employed in a discriminant analysis -- a statistical technique designed to weight and linearly combine a set of independent variables so that two or more groups in a nominal scale dependent variable are forced to be as statistically distinct as possible -- the three characteristics demonstrate a moderate amount of discrimination (as indicated by a .773 Wilkes' Lambda). The proportion of the variance explained on the discriminant function by the two groups (IDOE fundees and all other marine scientists) is 22.7 percent. The standardized discriminant function coefficients, which identify the relative contributions of the independent variables to group differentiation along the function are .84 for the number of agencies from which research support has been received, .31 for institutional affiliation (major ship supporting institution or not), and .30 for research orientation (basic, mixed, or applied).

A principal reason, perhaps, why a greater proportion of the variance is not explained by the discriminating variables is that while IDOE funding recipients tend to be heavily weighted toward one end of the professional spectrum, not all the oceanographers with these characteristics are disposed to participate in large scale, IDOE-type research.

Large scale research, of which IDOE is an example, remains controversial among oceanographers because of the peculiar traditions of the field and its incongruence with long-standing scientific norms. Even among IDOE fundees there exists a high level of attitudinal ambivalence to large scale science. When asked if they prefer to engage in highly coordinated, large scale projects IDOE funding recipients do not differ significantly from other oceanographers. Only 5.2 percent of the IDOE fundees compared to 4.1 percent of the others indicated they "always" prefer the large scale mode, 77.3 percent of IDOE fundees and 62.5 percent of the others indicated "sometimes", and 17.5 percent of IDOE fundees and 33.5 percent of the others claimed "never".

Majorities of both groups would prefer to see support for large scale and small scale research increased but support for small scale research is much higher even among IDOE fundees. Nobody would approve of cuts in grants to small scale research, but 6.4 percent of the IDOE fundees and 13.9 percent of the others indicate support for a reduction in expenditures in large scale research, even if the federal marine science budget were to be increased by 50 percent in real purchasing power over the next five years.

In short, IDOE funding recipients tend toward the elite end of the professional spectrum. They are clustered more heavily at the highly acclaimed, major ship supporting oceanographic institutions, they receive funding support from a

TABLE 5

APPLICATION OF INCREASED FEDERAL FUNDING TO OCEANOGRAPHIC NEEDS BY IDOE FUNDEES AND ALL OTHERS[a]
(percent by column)

	IDOE Fundees		Others	
	Large Scale Grants	Small Scale Grants	Large Scale Grants	Small Scale Grants
Increase	61.8	91.7	55.2	95.7
Maintain Current Level	31.9	8.3	30.9	4.3
Reduce	6.4	0.0	13.9	0.0
No. of Respondents	(157)	(156)	(567)	(568)

[a]If Federal support for academic marine science were to be increased by 50% in dollars of constant purchasing power over the next five years, where would you like to see the new money applied? (small grants for basic research; large scale grants for basic research)

greater number of federal agencies, and their research orientation is directed primarily toward basic investigations. Nevertheless, because of the ambivalence toward large scale research that permeates the entire oceanographic community, many oceanographers with these characteristics prefer the small scale mode of inquiry.

ANALYSIS

In previous sections of the chapter we described the nature of the influences of organizational environment, administrative arrangements, and clientele influences on the IDOE policy process. This section analyzes in a general sense the impact of those factors on IDOE.

W. Henry Lambright, in Governing Science and Technology, identifies two distinct approaches to science administration and the clientele relationships they engender (1976). The first, science oriented administration, suggests that some organizations are imbued with the values of the scientific community and operate in accordance with those values. The second, society oriented administration, operates according to a broader set of values. For Lambright, NSF is the archetypical science oriented agency, wehreas the R&D sections of agencies such as the Defense Department, HEW, Commerce, and Agriculture are more society oriented. Lambright identifies nine characteristics that distinguish the two administrative approaches to R&D.

1. Science-oriented administration takes its cues from the values of the scientific community; society-oriented administration is attentive to interests of politicians and various research users.

2. Science-oriented administration _supports_ research; society-oriented administration _purchases_ research.

3. Science-oriented administration allows the scientists to take the initiative in pursuing their own curiosities; society-oriented administration gives the initiative to the agency, which is looking for solutions "targeted" to particular public problems.

4. Science-oriented administration permits scientists often in determining ways, to participate in choosing, through peer review, which proposals are funded; society oriented administration chooses, through agency review, which proposals are funded.

5. Science-oriented administrators prefer to fund research through grants; society-oriented administration favors contracts.

6. Science oriented administration considers _excellence_, in terms of scientific criteria in proposals, most important; society-oriented administration considers _relevance_ to the agency's problems the key factor.

7. Science-oriented administrators like to deal with 'colleagues' in universities, particularly the most prestigious universities; society-oriented administrators will deal with any institutional performer willing and able to meet their needs...

8. Science-oriented administration takes a long-term view of its task. Thus, it will not only support research, but will build capability both in individuals through fellowships and at universities through institutional grants; society-oriented administration works for more immediate solutions and seeks to use existing capability rather than to create new capability.

> 9. Science-oriented administration believes researchers can manage for themselves and minimizes formal reviews from Washington; society-oriented administration values accountability and responsiveness to agency views highly and, therefore, requires considerable 'management' from Washington: site visits, frequent reports, 'milestones', evidence of results getting to users, etc. (Lambright, 1976:138-139).

Since 1969 when it was designated as lead agency in the planning, implementation, and management of IDOE, NSF has wielded considerable influence over the policy directions of the program. It molded a program that was largely in conformance with its dominant bureaucratic culture, mode of operation, and marine science clientele; a program, in other words, that conformed quite closely with the nine characteristics of science oriented administration depicted by Lambright.

Yet, although the Foundation was given planning responsibility for the IDOE, the Decade concept had been molded in a preliminary fashion by three years of discussions and scientific and governmental planning reports. Thus, in 1969, it was not totally unencumbered by commitments, several of which created friction within the Foundation and among its clientele.

First, the Decade concept evolved out of the desire to improve our understanding and knowledge of marine related phenomena that might lead eventually to tangible societal returns. Specifically, Decade planners focused on the mineral and living resources of the oceans, ocean pollution, and environmental forecasting. The commitment to the four research areas imposed constraints on marine scientists who developed viable research ideas outside the substantive jurisdiction of IDOE. This approach is contrary to the typical NSF system which is organized along academic discipline lines and which operates to support any research in the respective field as long as it is judged meritorious in peer review. NSF has been criticized by the basic science oceanographic community for this directed approach (Maxwell, 1977). Post-IDOE planning recommendations also suggest that the successor to IDOE consider a broader range of research topics (NAS, 1978). NSF and IDOE have responded to the criticism by supporting a broader range of research topics than might be strictly justified by the four program areas. One NSF official even declared that "if the science is 'top-flight' we will find the program relevance."

Second, Decade planners committed IDOE to a large scale approach to the problems. That is, the projects were supposed to be primarily interdisciplinary, multi-investigator, multi-institutional, and if possible international in approach. In addition, they were generally to be long-term, requiring funding support significantly larger than small scale investigations. The larger scale approach created problems for IDOE administration because the rationale for support of their constituent elements differed, on occasion, from that of the typical small scale NSF grant proposal. Scientific excellence is, of course, the primary consideration in both instances, but in the case of the large scale projects, not all of the support components can be considered viable research projects outside the whole, although they are often reviewed in that way. They are included in the large scale project to serve critical integrative functions for the larger experimental goals of the project and should be reviewed in that light. This distinction, too, is taken up in the major post-IDOE planning document (NAS, 1978).

The marine science community itself is ambivalent about the efficacy of large scale science and the size of its role in the Total Federal Marine Science Program. While most oceanographers agree that a permanent federal program for funding large scale science research projects would be desirable (73.4 percent of all IDOE fundees and 59.5 percent of all others interviewed in the University of Connecticut study), they place it very low on their list of funding priorities, sixteenth or a list of eighteen support areas, and more than for any other area they are likely to indicate that the federal financial commitment should be reduced.

Third, large scale projects often have lengthy time lags between their start and eventual publications of research results. The basic scientific community and NSF clientele is uneasy with the "lags" because they are left impotent to evaluate the scientific contributions of the project, yet are often requested to support continuing appropriations.

TABLE 6

RANK ORDERING OF AREAS
OF RECOMMENDED INCREASED
FEDERAL FINANCIAL SUPPORT
(percent by row)

Support Areas	Increase Funding	Maintain Current Level	Some Reduction	Number of Respondents
Small Basic Research Grants	94.9	5.1	0.0	742
Energy Development	85.8	11.7	2.5	709
Facilities and Equipment	80.3	14.7	0.4	699
Less Well Known Institutions	75.3	21.7	3.0	691
Environmental Forecasting	72.9	23.1	4.1	689
Living Resources	72.4	24.6	3.0	627
Biological Oceanography	71.9	23.1	5.0	683
Ship Operation	70.9	25.9	3.2	660
Marine Chemistry	70.7	26.0	3.3	658
Physical Oceanography	68.1	27.4	4.5	672
Coastal Management	66.7	26.6	6.7	684
Submarine G&G	65.7	27.3	7.1	664
Marine Resources	57.2	36.0	6.9	623
Well Established Centers	56.7	37.0	6.3	700
Large Scale Basic Research Grants	56.6	31.1	12.3	724
Ocean Engineering	52.1	41.2	6.7	645
Ship Construction	46.9	41.9	11.3	645

The financial risks are much smaller in small scale science, and results are more quickly reported in the literature. There is little the IDOE Office can do to overcome this problem except to provide more long-term support, but that approach merely trades one problem for another.

Fourth, large scale projects necessitate somewhat greater administrative oversight than do small scale projects because of the financial risks involved in their support. IDOE scientists, therefore, are required to submit progress reports and projected milestones. Program managers at IDOE also maintain continual contact with the project leaders in order to oversee operations and provide logistic and coordination assistance. As indicated in the section titled "The 'Typical' NSF System in Contrast" the Foundation's preferred mode of operation is to allocate the funds and leave the recipients alone for an entire year, and then contact them only to request a progress report or final report. IDOE has adapted to the NSF system by steering clear of interference with the scientific management of the project, and reducing the administrative oversight by requesting only semi-annual progress reports instead of the quarterly reports that were required at the outset of the Decade. The IDOE Office has also moved to eliminate administrative hassles during field work and other hectic stages of the projects by timing its paperwork requests during the slow periods or natural lulls in the projects.

Overall, though, IDOE has conformed quite closely to the NSF system. IDOE takes its cues from the basic science community of marine scientists and the National Academy of Sciences; it supports research; it has made every effort to stretch the four research areas to include projects that might be considered by most observers to be outside its mandate; it operates through peer review; it funds its research through grants; it prefers to deal with academics and research institution scientists; and while IDOE program managers are required to oversee the ongoing administration of the projects, they do not become directly involved with the management of the science itself.

CHAPTER IV

PROGRAM IMPLEMENTATION

INTRODUCTION

The U.S. IDOE program was initiated in 1969 to support a series of collaborative large scale investigations that would, it was hoped, provide the scientific and technical knowledge necessary to enhance utilization of ocean resources and provide marine environmental protection on a global scale.

In previous chapters we observed how pre-organizational, organizational, and outside interests affected the IDOE goals and policy process. In this chapter, six of IDOE's twenty projects are described to provide a greater understanding of the types of problems that have been investigated and how the projects have been managed. In addition, the projects are collectively assessed for the uniqueness of their contribution to the federal marine science program.

The six projects and the program offices from which they are administered include:

Environmental Forecasting

CLIMAP - Climate, Long Range Investigation, Mapping and Prediction

MODE/POLYMODE[a] - Mid-Ocean Dynamics Experiment

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[a]POLYMODE is the contraction of two acronyms, POLYGON which is the Soviet Union's version of MODE, and MODE.

Environmental Quality

GEOSECS - Geochemical Ocean Sections Study

CEPEX - Controlled Ecosystem Pollution Experiment

Seabed Assessment

MANOP - Managanese Nodules Program

The Eastern Atlantic Continental Margin Study

The projects were selected on the basis of discussions with several scientists involved in IDOE projects and with interested observers. My objective was to select a subset that reflected the breadth of scientific and management approaches brought to bear on the problems. The major problem that resulted from my selection process was that six were too many and did not allow me enough time to focus deeply enough on any one. Neither of the Living Resources projects are examined in detail because the science in both cases is being conducted on the West Coast and the scientists are unavailable for interviews. Literature on the Living Resources Program has been reviewed and the program manager interviewed, through, and these materials are included were appropriate.

GEOSECS

The Geochemical Ocean Sections Study (GEOSECS) is a project of detailed measurement of the oceanic constituents along Arctic to Antarctic sections of the three major oceans at all depths, to provide a set of physical and chemical data measured on the same water samples. The data are intended to serve two functions; first, as input for quantitative studies of oceanic mixing and organic productivity, and second, as a baseline for pollutants, fission, and waste products in the world's oceans (Spencer and Bainbridge, 1971:23).

Throughout the 1960's oceanographers tried and failed to develop models to explain the complex patterns of ocean movements. The scientists' lack of data and reliance on "fudge factors" made the models undependable. At a meeting in 1967 at the Woods Hole Oceanographic Institution the modelers gathered with a group of physical and chemical oceanographers to plead their case for more data. The meeting resulted in a program concept that called for "the most extensive, integrated, and comprehensive profile of any large body of water ever attempted" (1974:22). Between 30-50 geochemical and hydrographic measurements were to be taken at over 100 stations along north-south routes of the Atlantic Ocean, and later the Pacific and Indian Oceans.

Before the project could be undertaken, however, a funding source had to be located to support the ambitious idea. Fortunately, the IDOE concept was being molded in the Marine Sciences Council at the same time. In fact, the GEOSECS idea appears often in the IDOE planning documents as an example of a theoretically mature scientific idea in need of an appropriate large scale funding source.

GEOSECS planning, however, did not wait for IDOE. In 1968, over two years before IDOE was allocated funding, the GEOSECS planning group established a Scientific Advisory Council to oversee the scientific direction of the potential project, and an Executive Committee to handle its day-to-day progress.

In 1969, with the scientific program adequately honed, the scientists undertook the task of adapting, modifying, and even inventing the equipment that would be required for the mission. Later, they brought in Dr. Arnold Bainbridge of the Scripps Institution of Oceanography to oversee the development and integration of the equipment (NSF, 1974:22). At about the same time IDOE received its first appropriation of $15 million, of which GEOSECS received almost $3 million. Since its initiation, GEOSECS has been one of the most expensive IDOE projects.

TABLE 7

IDOE-GEOSECS EXPENDITURE
FY 1971-1977

Year	Amount
1971	[a]2,923,000
1972	[a]3,667,200
1973	[a]857,900
1974	2,410,900
1975	1,540,270
1976	1,696,400
1977	2,624,100

[a]Does not include ship support

Source: Internal IDOE documents

GEOSECS has involved three major field components. Between July 1972 and April 1973, the Knorr cruised the Atlantic and conducted 121 oceanographic stations along the main survey track. From August 1973 to June 1974, the Melville performed the same duty in the Pacific Ocean and accomplished 147 stations. Finally, the Melville was used again in the Indian Ocean phase from December 1977 to April 1978, and completed a similarly impressive number of stations (IDOE, 1978:1).

Three types of stations were occupied during each of the cruises. The first was for the standard salinity, temperature, and depth data. The second type was for most of the hydrographic data collected with the STD[a] and water samples collected with Nansen and Niskin bottles for analyses of dissolved gases, nutrients, suspended matter, and trace metals. The third type was large volume stations for the collection of radiochemical information (IDOE, 1973C:1). An innovation of the GEOSECS cruises was the development of instrumentation that could analyze the water samples immediately on ship.

Between 17 and 24 principal investigators from 15 different institutions have been involved in the GEOSECS project throughout its history. Most of the investigators have come from academic institutions and research laboratories, but individuals from the Navy Department, the Atomic Energy Commission, and the Battelle Pacific Northwest Laboratories have also participated. In addition, the GEOSECS scientists have coordinated their operations with investigators from several foreign countries including, Belgium, Canada, France, Germany, India, Japan and the United Kingdom (IDOE, 1978:1).

The GEOSECS project, like most other IDOE supported large scale projects, has required a sophisticated - for marine science - management scheme. As mentioned above,the scientific direction for GEOSECS is provided by the Scientific Advisory Committee composed of 12 principal investigators. The committee is responsible,as well,for selecting the proposals to be included in the project, and recommending modifica-

[a]STD is an instrument for measuring salinity, temperature, and depth.

tions in individual proposals.

The Executive Committee of GEOSECS is composed of three members of the Scientific Advisory Committee. It is their responsibility to make the day-to-day decisions for the project, oversee proposal preparation, maintain control over publications, mediate disputes, and generally implement the long-range policy of the Advisory Committee. One member of the Executive Committee serves as the Coordinator or contact point with the IDOE Office, and it is his responsibility to handle the routine administrative matters that do not require Executive Committee action. In the GEOSECS project the Executive Committee is composed of individuals who are the scientific leaders, as well as the management leaders of the team. Because each is such a "powerful personality", they insist on rotating the position among themselves in order to "stay on top of things" (Broecker, 1978). Another member of the Executive Committee acts as the coordinator with the related international projects, but that role is a minor one and foreign contacts are irregular.

The Executive Committee employs the services of an Information Officer whose primary responsibility is to complete the paper work required by IDOE. In the first few years of IDOE, quarterly reports were required and it was the Information Officer's job to gather the materials and forward the report to Washington, D.C. Recently, reporting requirements were cutback to a semi-annual basis. The Infor-

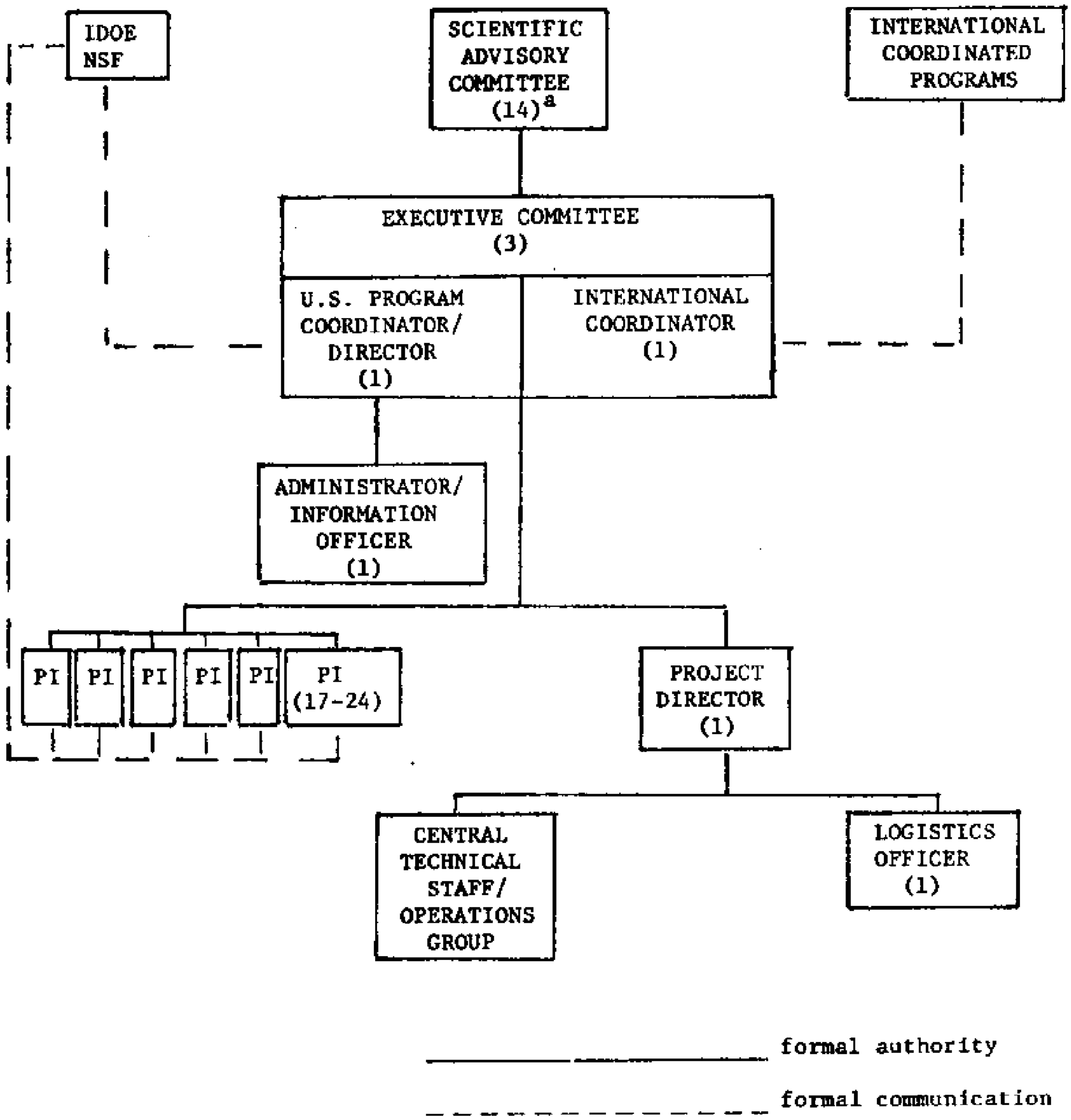

FIGURE 13. GEOSECS ORGANIZATIONAL STRUCTURE

[a]Numbers in parentheses indicate the number of Scientists involved in the positions. This applied to all subsequent organizational charts.

mation Officer is also responsible for internal communications, providing information to outsiders, and general service as the Coordinator's deputy.

Immediately under the line authority of the Executive Committee is the Project Director. It is his responsibility to oversee the organization, staffing, and maintenance of shipborad operations, handle logistical details, develop instrumentation, and design the experiments. Because of his extensive responsibilities he is considered the fourth (ex officio) member of the Executive Committee.

The principal investigators also come directly under the authority of the Executive Committee on the organization chart. They are responsible for the conduct of their own experiments, supplying information to other team members, and cooperating with the team toward project goals. The PI's, however, deal directly through their institutions with the IDOE Office regarding funding and review questions and decisions. The PI's relationship to the IDOE is the same for all the projects.

While the GEOSECS management structure appears very differentiated, in fact, the Executive Committee maintains tight control over all aspects of the project. The Advisory Committee is convened primarily to discuss financial matters. At first, the IDOE Office was resistant to the three man control and rotating Coordinator. In fact, the IDOE Office attempted to superimpose a more detailed management structure on the project, and invited a management consultant team to a GEOSECS Executive Committee meeting to discuss the issue. The idea failed for three reasons. First, marine scientists at universities and research laboratories have always managed their own science, often several projects at once, and saw no need to bring in a group of non-oceanographers to help design a structure for them. Second, oceanographers do not like to spend research dollars on non-science aspects of a project--least of all administration. Third, although IDOE science is considered large scale, it is dwarfed by the really large scale NASA-type projects for example, and is not suitable for complex management schemes (Broecker, 1978; Spencer, 1978).

Among the findings of the GEOSECS project are the:

> Discovery that radioactive chemical tracers can provide information about large-scale ocean mixing patterns and rates of water movement;
>
> derivation of eddy diffusivity through the measurement of a short-lived natural radioactive component of dissolved matter in seawater;
>
> development of vertical transport models based on evidence that fecal pellets from zooplankters and small fish, along with clays, appear to scavenge from seawater soluble constituents, such as heavy metals;
>
> identification of three major water types in the western basin of the Atlantic on the basis of their concentration of dissolved oxygen and dissolved nitrate (IDOE, 1977b:1).

The possibility of applying GEOSECS findings for socially useful purposes has been described in the Harbridge House evaluation of IDOE as having high potential (1976:IV-32). In the long run it may provide information useful to an understanding of the pollutant disposal capability of the oceans, the ocean circulation and its consequences for atmospheric processes and climate change, and nutrient circulation and its significance for supporting plant and animal life (GEOSECS, Advisory Committee 1970:7).

CEPEX

CEPEX, or the Controlled Ecosystem Pollution Experiment, is a research effort designed to test the effects of natural processes and pollutants on the structure and function of open ocean (pelagic) marine ecosystems in simulated semi-natural environments. Bags of flexible plastic material (called Controlled Environmental Ecosystems or CEE's) are used as simulators to impound the natural populations of marine species for experimental periods of up to 100 days.

The CEPEX project was conceived at a meeting held in Savannah, Georgia, in September 1972, sponsored by the NSF-IDOE office. The purpose of the meeting was to make specific recommendations to IDOE for a study of the impact of pollutants on ocean ecosystems. Fourteen individuals from 12 different academic/research institutions, 3 countries, and the IDOE Office attended the meeting.

Following the meeting a report on program suggestions was submitted to the IDOE Office. Further IDOE encouragement led to a full proposal by scientists from five American universities and research laboratories with cooperative inputs from two foreign institutions. Dr. David Menzel oversaw the draft proposal and was largely responsible for hand-picking the scientists that he wanted to include in the proposal.

The proposal was satisfactorily reviewed by IDOE and funded at a level of almost $1,300,000 in FY 1973.

TABLE 8

IDOE-CEPEX EXPENDITURES
FY 1973-1977

Year	Amount
1973	$1,294,600
1974	806,800
1975	1,363,800
1976	749,300
1977	522,100

Source: Internal IDOE documents.

Although successful in obtaining funds, some reviewers considered the project not sufficiently large scale or integrated enough for IDOE support. Subsequent reviews have been equally controversial on the same grounds, but CEPEX has endured.

Between 1973 and 1977 CEPEX involved between 9 and 11 principal investigators from five American institutions in the general fields of chemistry and biology. With a change in project emphasis from pollutant stresses to natural stresses and with a change in project leadership, the project size increased to 13 principal investigators from 10 institutions in 1978 (CEPEX Steering Committee, 1978).

Following numerous planning sessions, preparatory baseline pollutant studies, and pollutant transfer investigations, the CEPEX project was initiated. The general research plan of CEPEX in its early years was to:

> Identify modes by which organisms accumulate pollutants from the environment;
>
> Determine relative rates of uptake, excretion and accumulation of pollutants at various trophic levels;
>
> Identify first indications that metabolic functions of specific groups of organisms have been altered and determine what net effect of this alteration may be; and
>
> Identify species most susceptible to physiological damage (NSF, 1974c:6).

In 1978 the project redirected itself under new leadership "towards understanding the natural mechanisms controlling the structure and function of pelagic marine ecosystems, with the expectation that this will increase our comprehension of the effects of pollutants in both past and future experiments" (CEPEX , 1977).

The field operation of the CEPEX project represented a compromise between an open ocean system in which it would be impossible to control the rates of chemical and biological input, flux, and removal from the experimental area, and a laboratory situation in which two or more trophic levels (one of a hierarchical strata of a food web) of organisms could not be maintained and analyzed for interaction effects. The use of large plastic bags to "cut out a piece of the ocean" provided a more realistic setting (NSF, 1978d:13). The biggest drawback of the bags, however, has been the lack of horizontal and vertical exchange of water through them. But, the investigators are attempting to resolve the mixing problem through the use of pumps (NSF, 1978d:18).

The bags, actually flexible polyethylene cylinders, have been developed in three sizes for the CEPEX project, the largest of which is almost 10 meters in diameter and 29 meters long (CEPEX, 1977). The CEE's are employed by SCUBA equipped divers who raise the cylinders over columns of water in order to, it is hoped, capture sections of the natural ocean system. The bags are raised to the surface and attached to floating steel tubular spheres. Once attached the contents of the bag are ready for experimentation.

Saanich Inlet near Victoria, B.C., Canada, is the site of the field experiment. It was selected by the team as the most suitable site for several reasons including, its shelter form the harshest ocean conditions, low current velocities, its deep water depth,its high level of biological productivity, its relatively simple food webs or systems, its remote location far from sources of pollution, and its open ocean-like plankton composition (NSF, 1974:6). Site operations are subcontracted by CEPEX to the University of British Columbia and Case Existological Laboratories which designed and maintain the CEE's.

The CEPEX project is managed by a Steering Committee of 5 members who oversee the general conduct of the project, provide scientific review or quality control, and other functions similar to the Scientific Advisory Committee of GEOSECS. Rather than an Executive Committee of multiple members as in most other IDOE projects, a single Coordinator makes the day-to-day CEPEX decisions. The management of CEPEX is much more centralized than in most other IDOE projects, perhaps because of its small size and the nature of its field work.

It is the responsibility of the Coordinator to communicate with and serve as the general contact point with the IDOE Office and the international cooperative projects. He is assisted in his responsibility by an Administrative Coordinator who performs primarily secretarial duties. Also, under the authority of the Coordinator is the On-Site Coordinator and the PI's. It is the On-Site Coordinator's responsibility to oversee the maintenance of facilities and the conduct of the scientific program at Saanich Inlet. The PI's are responsible for their individual research problems

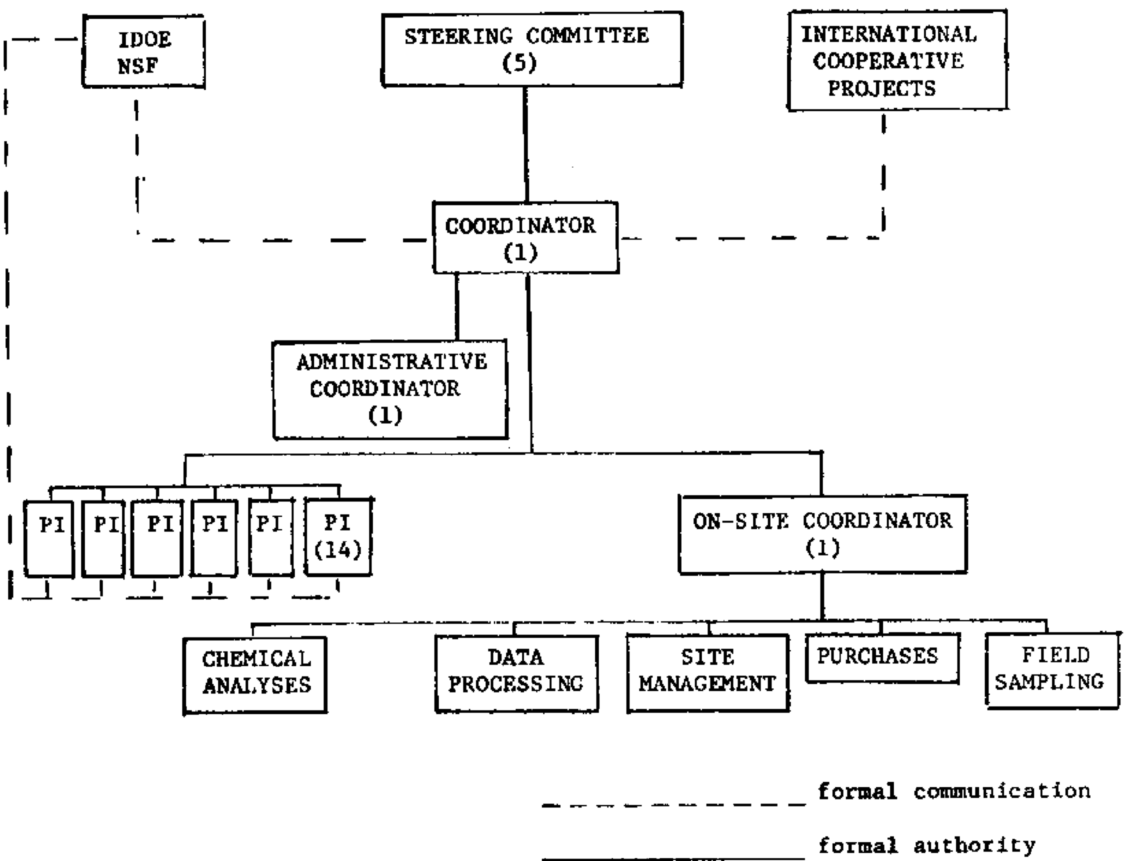

FIGURE 14. CEPEX ORGANIZATIONAL STRUCTURE

and cooperating with team members in arranging for time to conduct the experiments and providing them data when necessary.

Results from the CEPEX project pollutant stress phase suggest that:

> (d)espite massive mortality, organisms from microbes to zooplankton recovered at the concentration of pollutants tested, because mortality, although exceeding 50 percent, never reached 100 percent. Although bacteria were affected first, their rapid generation time (house), the different makeup of numerous strains, and their ability to mutate allowed for a rapid recovery of heterotrophic activity. Zooplankton with relatively few species, numbers of individuals, and longer generation times (weeks to months) recovered most slowly. Phytoplankton with intermediate characteristics were intermediate in their recovery rates. Although there was no observed mortality of fish, metal concentrations in their tissues were greatly elevated and growth rates were reduced. If such effects on fish are cumulative, their recovery would have been less likely on experiments of longer duration (NSF, 1978:17).

Results from the CEPEX project natural stress phase have not been reported as of this writing. The CEPEX project was devised as an effort to simulate open ocean effects of pollutant stresses on the marine environment, but the limitations of the bags have been too severe for a very rigorous simulation. "It seems clear that artificial ecosystems of this type cannot be expected to mimic the natural environment..." (Harbridge House, 1976:IV-37). Nevertheless, the results of the CEPEX experiments are an improvement over the type of laboratory experimentation that served as the basis of a great deal of information on the effects of pollutants on marine systems.

CLIMAP

The Climate, Long Range Investigation Mapping and Prediction (CLIMAP) study is "designed to describe and explain the major changes in global climate that have occurred in the past million years" (NSF, 1978:45). The objective is being met primarily through the examination of plant, animal and chemical elements found in seafloor sediment cores--one of nature's most reliable and informative archives of conditions in ancient seas (NSF, 1977c?:8). "Recent advances in dating techniques, automated analyses of individual sediment cores, and computer correlation of the many features in the sediment strata" have made the global recreation of ancient climatic conditions possible (NSF, 1973c:20).

The origins of CLIMAP date back to the mid-1960's when a group of geologists at the Lamont-Doherty Geological Observatory of Columbia University began considering use of the sediment cores of the Deep Sea Drilling Project (DSDP) for a study of paleo-oceanography dating back millions of years. They soon realized that the DSDP cores were inappropriate for the investigation they hoped to conduct. They refocused their sites on more discrete time scales, and brought in additional scientists from Lamont and other institutions to assist their efforts. In 1971 the project involved only five principal investigators. In subsequent years the number of PI's expanded greatly, averaging 25 from six institutions.

The IDOE Office was not immediately receptive to the CLIMAP idea because of the low social applicability potential for studying historical climatic trends of tens of thousands of years. Nevertheless, the scientists eventually succeeded in obtaining IDOE support, because of the high quality of the proposal. Despite the absence of any major field work, due to the availability of sediment cores, CLIMAP has received substantial funding.

TABLE 9

IDOE-CLIMAP EXPENDITURES
FY 1971-1977

Year	Amount
1971	$ 619,000
1972	720,800
1973	2,063,400
1974	307,100
1975	142,600
1976	1,313,600
1977	250,000

Source: Internal IDOE documents

A great deal of the funding has been spent on conducting and traveling to semi-annual meetings. The meetings have played a major coordinating and integrating function for the CLIMAP project by affording the scientists the opoortunity to discuss their individual and collective progress (McIntyre, 1978; Cline, 1978).

CLIMAP has developed a management structure to oversee the science and its synthesis. It is considered a model within the Environmental Forecasting Program. An Executive Committee, consisting of scientists from each of the participating institutions, assumes overall responsibility for the project, coordinates the activities of task groups, assures the free flow of information among institutions, and controls all CLIMAP publications (NSF, 1977c?:11; McIntyre, 1978; Cline, 1978).

An Executive Committee member serves as Project Director and is responsible for day-to-day operations and oversight of scientific progress and budgets. He is assisted in this work by an Administrative Assistant. One of the major functions of the Administrative Assistant is to plan and implement all aspects of the semi-annual meetings.

The PI's are responsible to the Executive Committee for the conduct of their individual research tasks. They are also responsible to the Executive Committee as members of the three principal scientific programs.

> Global Climate Reconstruction Program--
> This program is assembling synoptic arrays of data to reconstruct past changes and near equilibrium states of the global climate.
>
> Regional Climate Dynamics Program--
> Objectives of this program are to

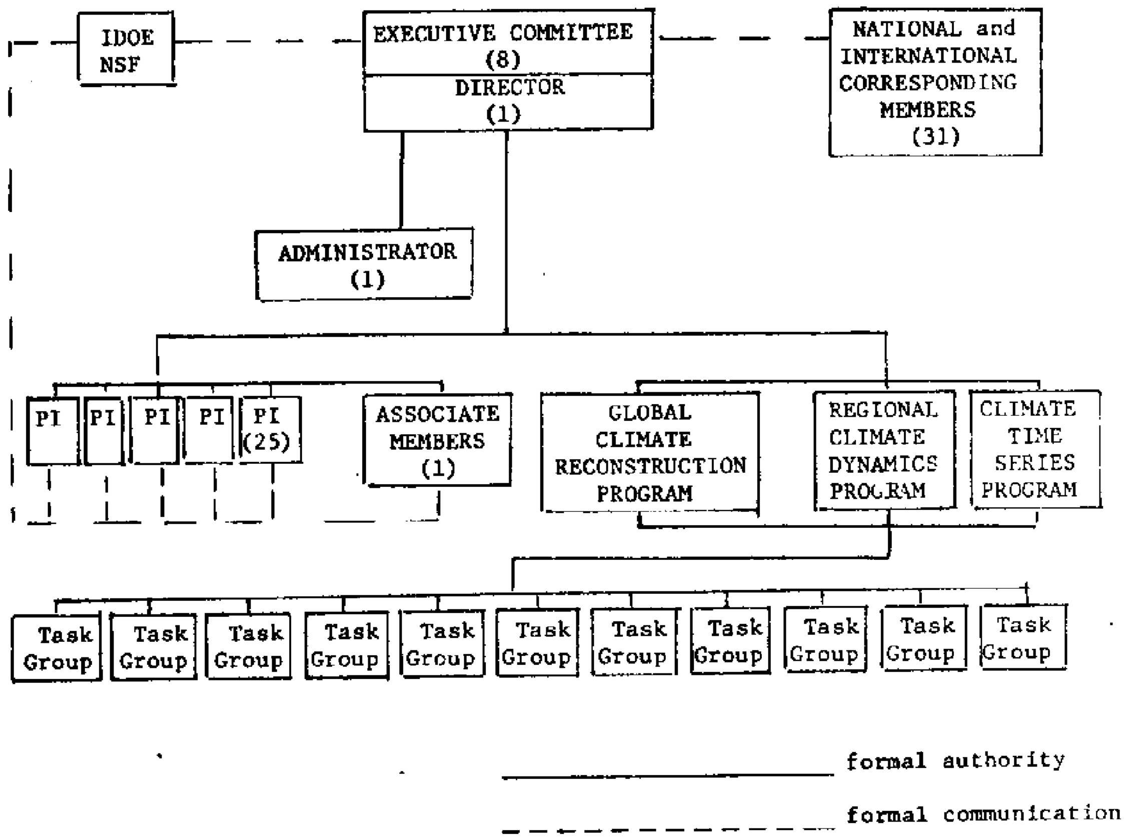

FIGURE 15. CLIMAP ORGANIZATIONAL STRUCTURE

identify regions and specific mechanisms that play critical or controlling roles in climatic change.

Climatic Time-Series Program--This program generates time-series of variables considered to be significant indices of climate. The time-series are analyzed for periodicities.

Beneath the three scientific programs is an array of task groups that are organized by geographic, substantive, and support categories.

Some of the CLIMAP advances include a global reconstruction of the last ice-age maximum 18,000 years ago, the last inter-glacial minimum 120,000 years ago, and the determination of periodicities in the climatic record that match precisely with periodicities of the Earth's orbital parameters (CLIMAP Project Members, 1976:1131-1144; Hays et. al., 1976: 1121-1132; NSF, 1976:25; NSF, 1978:45).

But although the project results have been of high quality and interest, the long time scales involved in climatic transitions between glacial and interglacial periods make the project of little immediate use (Harbridge House, 1976: IV-72-73).

MODE/POLYMODE

MODE, or Mid-Ocean Dynamics Experiment, was a five-year project to increase understanding of ocean circulation through a study of low frequency, intermediate scale motions or eddies. Eddies are energetic systems that move in circular motions, occupy the entire water column, and may be over 100 kilometers in diameter (MODE-I Scientific Council, 1971:1). POLYMODE is the international successor to MODE. Its long-range goal is to determine the role of eddy variability in the dynamics ot the large scale general circulation of the oceans (U.S. POLYMODE Organizing Committee, 1976:1).

The MODE project originated formally in July 1970, at a meeting at the Woods Hole Oceanographic Institution. At that time a group of physical oceanographers and ocean modelers determined that the time was right, theoretically and technologically, to undertake a long-term study of ocean eddies. The existence of eddies has been known since the early 1960's but instrumentation lagged seriously behind the theories and prevented the scientists from undertaking the field work. Technical advancement in the 1960's, however, finally made the MODE project feasible. Neutrally buoyant floats had been developed that could maintain a consistent ocean depth for considerable periods of time and transmit data back to shore; sophisticated current meters had been invented that could record water speed and direction on a magnetic tape cassette contained in the instrument; a towed device had been developed to map the density of surfaces in the eddy field with fine horizontal resolution; and a great number of other instruments had evolved that could be incorporated into a physical oceanographic project such as MODE (Daly, 1975:4-5).

Subsequent meetings in Moscow under the auspices of the

United Nation's Scientific Committee on Oceanic Research (SCOR) Working Group 34, and later at Woods Hole under IDOE sponsorship, resulted in the formation of an organization, the Scientific Council, to oversee development of a scientific plan.

Because much of the instrumentation was only at the development stage, and because the scientists had little knowledge of the phenomenon to be investigated, a multiplicity of research instruments were selected for use, but the scientists were cautioned not to be too reliant on the test results of others. In other words, planning was "based upon the cautious principle of children playing in a sandbox: nominally playing together, but each in fact building his own sandcastle" (Wunsch, 1976:47). In this respect MODE differed greatly from projects such as GEOSECS, CEPEX, and CLIMAP which have depended heavily on a high degree of cooperation among participants.

The location and duration of the MODE project was also dictated by the instrumentation; it had to be close enough to shore to be within tracking range of the floats, accessible to U.S. East Coast ports because of the need for several ships, and no more than several months in duration because instrumentation endurance was low. The site selected was a 600 kilometer-wide area east of Florida and south of the Bahamas, over a varied topography that included abyssal hills, abyssal plains and continental rise (MODE-I Scientific Council, 1973:12; Wunsch, 1976:47).

The complexity and scope of the undertaking necessitated the construction of an elaborate organization structure including Scientific Council, Executive Committee, Theoretical Panel, and several experimental and logistical committees. The Scientific Council assumed responsibility for the scientific goals and content of the project and consisted of "representative principal investigators from each of the experimental projects and the Theoretical Panel" (MODE-I Scientific Council, 1973:35). It met "every few months, for planning, exchange of information, assessment and interpretation of data, and evaluation of the program" (MODE-I Scientific Council, 1973:35).

The Executive Committee was composed of six members led by Co-chairmen Allan Robinson and Henry Stommel, who were also the scientific leaders of the project, and an Executive Officer in charge of all administration, communication, and governmental liaison functions. It was also the Executive Officer's responsibility to maintain an updated progress report for the project including the progress of each of the individual principal investigators.

Beneath the Executive Committee on the organization chart were the principal investigators. They were guided and evaluated in their work by the Scientific Council, and, as in all other IDOE projects, they received financial support directly from the IDOE Office via their home institutions. Their proposals were subject to NSF evaluation procedures. The fundees of theoretical projects were exceptions to the rule.

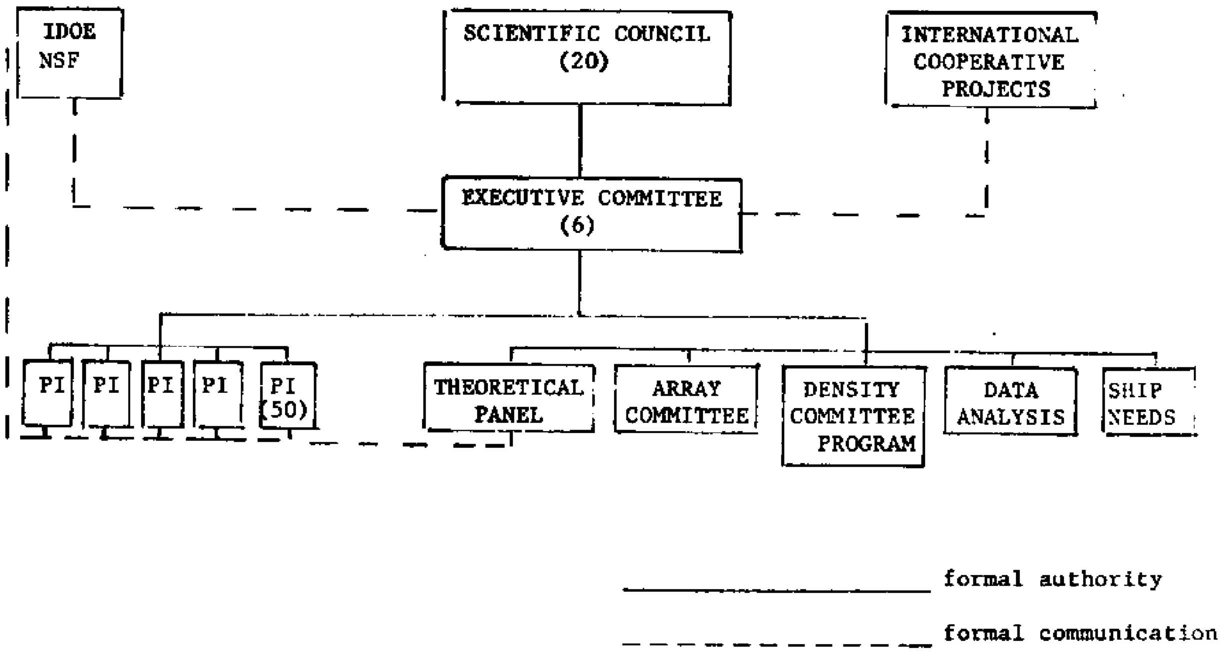

FIGURE 16. MODE ORGANIZATIONAL STRUCTURE

"Theoretical Projects were supported from block funds distributed directly from the International Decade of Ocean Exploration on the recommendation of the Theoretical Panel" (MODE-I Scientific Council, 1973:35). This arrangement was unique to the MODE project. It was not generally advocated by the IDOE Office or most other project leaders because it was believed it would tend to reduce team members' loyalties to their home institutions.

Individual principal investigators also served on pertinent project committees such as the Array Committee, Density Committee, Data Analysis Committee, Ship Needs Committee and othe ad hoc committees, which also came under the authority of the Executive Committee. The Committees served coordinating functions but were sparingly used (Heinmiller, 1978).

The total number of MODE participants at any one time approximated 50 scientists and hundreds of technicians and support personnel. Scientists from 15 American universities and research institutions in the United States were affiliated with the project. Investigators from Great Britain also participated, supported by their own government.

The size, complexity, and scale of the project, and its requirements for synoptic ship and plane operations made MODE one of IDOE's most expensive early projects.

TABLE 10

IDOE-MODE Expenditures
FY 1971-1977

Year	Amount
1971	$1,969,600
1972	3,485,000
1973	735,400
1974	1,177,900
1975	304,200

Source: Internal IDOE documents

Prior to the major MODE field experiment three arrays of current meters were deployed near the end of 1971 which provided valuable information on eddy scales, frequencies, amplitudes, and topographic effects. The pre-MODE or MODE-O work thus provided data for summer-long discussions in 1972 on the design specifics of the principal field experiment, MODE-1.

By 1973 the team was able to proceed with MODE-1. The major field experiment of over four months duration began in March 1973. Throughout the period, moorings and floats were set, profilers were placed, and measurements were continuously taken. At the conclusion of the field experiment "a vast amount of new data emerged and the long process of making sense of it began" (Wunsch, 1976:49).

The results of MODE-1 confirmed the existence of an open ocean eddy field and concluded that it was possible to monitor eddy behavior and describe its characteristics. It also suggested that ocean bottom topography influenced eddy behavior and that sharp temperature differences between the warm surface layers of eddies and cold deeper layers may contain a source of energy for the eddies (Daly, 1975:6).

The NSF evaluation of MODE concluded generally that while the quality of the science was high, interaction among scientists and synthesis of research results was low, and applied utilization of results were remote and long term (Harbridge House, 1976:IV-51, 54, 56).

POLYMODE, the international successor to MODE, is based on much of the MODE experimentation as well as that of the Soviet Union's POLYGON project, whose purpose was similar to MODE's. The ongoing POLYMODE investigation involves synoptic testing of currents, density, temperature, and other factors by American and Russian oceanographers with instrumentation and ships from both countries. The experimentation is in the same general area as the MODE experiment although over a much broader field.

The objectives of the U.S. POLYMODE project are:

> to carry out field observations and experiments, primarily in open ocean regions of the western North Atlantic, designed to advance our knowledge of the kinematics and dynamics of the variability in that region and to determine their role in the circulation of the North Atlantic subtropical gyre; and

> to pursue theoretical/numerical modeling of the phenomenon and to apply theory to the design and rationalization of the POLYMODE field data via both local forecast-process numerical models and high resolution numerical models of the North Atlantic gyre general circulation (Webster, 1977:1).

The experiment has required close communication and coordination among participants (approximately 35 U.S. scientists) and necessitated an elaborate management framework that includes a Joint U.S.-U.S.S.R. POLYMODE Organizing Committee which meets twice a year and shares responsibility for the planning and performance of the Joint Program, and a Joint Executive Committee and associated Working Groups. "There are joint Co-chairmen, an Executive Scientist and an Executive Manager on the U.S. side, and an Executive Officer on the U.S.S.R. side" (U.S. POLYMODE Organizing Committee, 1976:76). The U.S. program itself is organized similarly to MODE.

The average yearly cost of POLYMODE has been roughly the same as its predecessor, but the administrative/travel expenses have been significantly higher for POLYMODE, averaging over one three-year period approximately $330,000 per year.

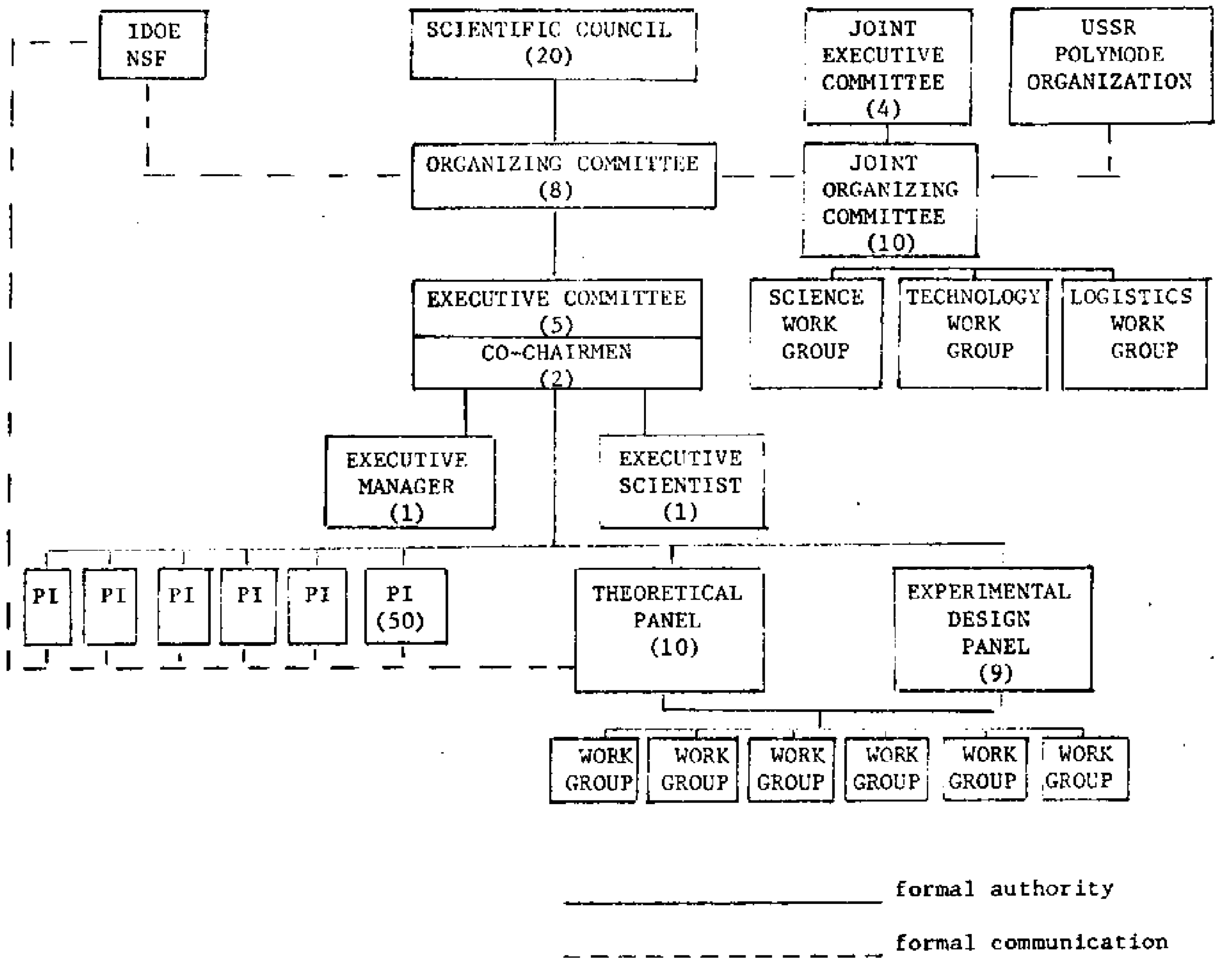

FIGURE 17. POLYMODE ORGANIZATIONAL STRUCTURE

TABLE 11

IDOE-POLYMODE EXPENDITURES
FY 1975-1977

Year	Amount
1975	$1,951,400
1976	1,767,100
1977	1,755,100

Source: Internal IDOE documents

Memos circulating among American participants in the POLYMODE project have expressed disgust and outrage at the high costs of administration. The scientists would have much preferred to have the money spent on many small scale studies (Schmitz, 1974).

EASTERN ATLANTIC CONTINENTAL MARGIN STUDY

The Eastern Atlantic Continental Margin study was an effort to determine the geological patterns along the western coast of Africa and to relate them to theories of sea floor spreading[a] which might lead, in turn, to information on mineral and biological resources on the continental shelf and slope (WHOI, 1971:8-10).

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[a]Sea floor spreading is a theory that suggests the ocean floor moves from the point where it is created at the ocean ridges to the point where it is subducted at the trenches, almost like a "giant conveyor belt" (Schlee, 1973:317).

The project had its origins in 1968 at the ninth general meeting of the Scientific Committee on Oceanic Research (SCOR). SCOR appointed a Working Committee to arrange a symposium on the Eastern Atlantic Continental Margin. The meeting was held under the auspices of SCOR and the International Union of Geological Sciences (IUGS) at Cambridge University, England, in March 1970. "About 250 invited participants from twenty nations attended, representing universities, geological surveys, oceanographic institutions, and industry. Twenty-eight talks were given by nearly 100 authors from many of the nations bordering the eastern Atlantic Ocean" (WHOI, 1971:5). Dr. K.O. Emery, who was later to serve as Chief Scientist on the Continental Margins study, served as Vice Chairman of the meeting. The talks and papers revealed clear differences between the results of marine geological studies along the European and African coasts. It also spotlighted the eclectic way that marine data had been traditionally collected and shared.

"At the end of the symposium there was much discussion about means of conducting a comprehensive study of the continental margin particularly off western Africa, with organizations of England, France, Germany, and the United States cooperating. One result was the funding of a geophysical study of the region by the United States International Decade of Ocean Exploration through the Woods Hole Oceanographic Institution" (WHOI, 1971:5). The Eastern Atlantic Continental Margin study was one of the first IDOE supported projects. In 1971 it received $458,000, and over its four-year duration it was awarded approximately $2,300,000 - a small project compared to most of the others funded by IDOE.

TABLE 12

IDOE-EASTERN CONTINENTAL MARGIN STUDY
EXPENDITURES FY 1971-1974

Year	Amount
1971	$ 458,000
1972	775,000
1973	823,000
1974	223,000

Source: The Eastern Atlantic Continental Margin Research Proposal submitted to the National Science Foundation by the Woods Hole Oceanographic Institution, 1971

The field work included two cruises. The first cruise on the Atlantis II extended from January 1972 to July 1972, and completed nearly 50,000 kilometers of geological surveying on 7 legs between Port Elizabeth, Republic of South Africa, and the Congo River with particular emphasis on the continental margin (NSF, 1973c:27). The second cruise of almost 50,000 kilometers extended from the Congo to Portugal and was conducted on the Atlantis II between January 1973 and June of the same year.

Continuous profiling of the ocean floor on the continental margin was made by seismic reflection, refraction, gravity, and magnetics. "Plotting of all of these geophysical parameters was automatic, with the computers adjusting both profiles and map plots according to positions obtained with a satellite navigator" (Emery, 1973:53). In addition, geochemical and physical data were collected that did not require the ship to stop.

Nine principal investigators participated in the four-year project, all from the Woods Hole Oceanographic Institution. "Every effort was made during six to eighteen months prior to the cruises to interest and invite participants from African West Coast governments. No foreign science was supported during the project, only travel expenses and room and board on ship. Most foreign participation was limited to observation. Other national and international participation was similarly restricted. A list of shipboard representatives included:

Africa
- Congo:1
- Ghana:6
- Senegal:1
- South Africa and South West Africa:11

Europe
- England:3
- France:3
- Germany:2
- Israel:1
- Portugal:2
- Spain:2

South America, Central America,
Caribbean
Argentina:1
Brazil:6
Guatemala:1
Jamaica:1

Asia
Taiwan:1

North America
United States (other than WHOI):13
(Emery, 1973:55)

The Eastern Atlantic Continental Margin study was conducted without a formal management structure for several reasons. First, it was initiated before management criteria were clearly defined by the IDOE office. Second, it was small enough not to require a management system. Third, all the principal investigators came from WHOI and were readily available for consultation throughout the project (Emery, 1978).

Many significant findings have arisen from the Eastern Atlantic Continental Margin study including some with economic importance. Several potential sources of oil accumulation were located by the scientists, speculation on potential fishery resources were made based on water characteristics and observed upwelling phenomena, and information was collected that verified the sea floor spreading theory.

MANGANESE NODULES PROJECT/MANOP

The Manganese Nodules Project/MANOP is actually two projects with distinct scientific objectives and personnel. The objectives of the original project were to assess all available information, records, and geologic samples of manganese nodules that existed, and to undertake to collect many of its own samples and identify significant parameters that might affect nodule development and variability. The objectives of the MANOP project have been more process oriented. "MANOP has concentrated on the paths and mechanisms that carry economically important elements, such as copper and nickel to the sea floor and lead to their incorporation in the nodules" (NSF, 1978:64).

The original Manganese Nodules project was the brainchild of Maurice Ewing, a geologist from the Lamont-Doherty Geological Observatory. He persuaded IDOE to sponsor a conference-workshop on ferromanganese nodules, because of the economic potential of mining the nodules from the seafloor and the significant interest of the IDOE planners in the mineral resources. The conference took place January 20-22, 1972, at Arden House, Harriman, New York. It was attended by over 150 representatives from academe, government, private industry, and several foreign countries. Thirty research papers were delivered and several task teams were formed around the issues of nodule origins, distribution, mining, and economic potential. Following the conference a "coordinating office was set up at LDGO to administer a multifaceted definition study (to be conducted) by 10 investigators from Columbia University and 10 others from as many other institutions" (NSF, 1973c:35). The definition work was referred to as Phase I.

Following a funding hiatus in 1973, Phase II was initiated. Its objectives were "to collect well-defined suites of samples (including substrata and bottom waters) and, through interrelated studies of varying approach, to identify and investigate significant parameters" (NSF, 1974: 28). This phase was to "focus on factors in the transition cycles of the elements from their sources in the ocean to their ultimate deposition as seafloor nodules; distribution of nodule-forming elements in seawater and substrata, including pore water; role of biological agents in nodule formation; and the influence of bottom currents, temperature, topography, composition, and processes" (NSF, 1974c:28).

TABLE 13

IDOE-MANGANESE NODULES/
MANOP EXPENDITURES
FY 1972-1977

Year	Amount
1972	304,200
1973	149,800
1974	585,900
1975	786,200
1976	626,500
1977	1,193,400

Source: Internal IDOE documents

A Scientific Council was established at the outset of Phase II to provide greater direction to the project. "The Council functioned also in a proposal screening capacity reviewing 40 original proposals, 14 of which were finally submitted to the National Science Foundation for funding" (NSF, 1975:36).

Three cruises totalling 55 days aboard the research vessel Moana Wave were conducted as part of the Phase II survey and sampling program. In addition, a 30-day cruise supported by NOAA and several commercial companies contributed valuable data to the project. Subsequent short cruises and experimentation brought Phase II to a conclusion in 1976.

Although the principal investigators supported by IDOE to conduct the research were almost exclusively academics, there was significant interest and involvement by private industry. Representatives from Kennecott Exploration, Inc., Deep Sea Ventures, Inc., and Ocean Resources Inc., served as program advisors in 1973 and 1974. In addition, much of the equipment used on program cruises was made available from private industry (NSF, 1975:36). International interest was also widespread in the nodule project. Although IDOE did not support any foreign scientific research, it paid for travel expenses to meetings and provided room for foreign investigators on the ships conducting nodule cruises.

Despite the optimism that preceded the initiation of the Manganese Nodules Project the results of the first two phases of it were judged unsuccessful by fellow oceanographers. No significant advancement in an understanding of nodule origin, distribution of development was forthcoming; and the work was not integrated sufficiently to justify continuation of a large scale approach according to their evaluations. Only the development of an ocean bottom monitoring package for measuring suspended sediment concentration in the near bottom water was deemed a significant contribution. Harbridge House, on the other hand, concluded that "(t)he early products of the Manganese Nodule investigation have been widely utilized by governmental bodies in the U.S. and abroad, by school classes and media, and by commercial firms in the early stages of considering participation in nodule mining" (Harbridge House, 1976:IV-145). The report recognized, however, that the project enjoyed no prestige among scientists.

The IDOE office was prepared to discontinue funding of the Manganese Nodules Project unless the scientists could reshape a project that might advance man's understanding of nodule development and which would benefit from a large scale approach. A workshop was convened on March 3, 1976 at the Battelle Conference Center in Seattle, Washington, to consider the problems.

A series of presentations was made at the conference that emphasized the need to refocus the program from a study of indirect measurement of nodule parameters to one of more direct measurement through the use of sophisticated remote sensing instruments that could be deployed on the seafloor for extended periods of time.

Following the presentations a new governing board was elected including only one member of the former project to assist in the transition. The Steering Committee, as it was called, met with the IDOE officials at the conclusion of the conference to set deadlines for preparing a new project plan. They also outlined a strategy for drawing up the plan which included consideration of a public announcement for proposal suggestions, construction of an advisory mechanism to consider the letter proposals as they came in, and choice of a new project director.

Dr. G. Ross Heath was selected to direct MANOP. He and the Committee received over 50 letter proposals. Approximately 20 were accepted as constituting a well-integrated approach to the problems that interested the new MANOP leaders. Letters were returned to the scientists requesting them to expand on their ideas, and suggesting how their proposals would fit into the overall project. After several more contacts with prospective team members and the development of a field program under the direction of Dr. Ray Weiss the final proposal was submitted to IDOE. The proposal was accepted with minor modifications.

MANOP is currently investigating "the influx, remobilization and final disposition of transition metals supplied to the deep-sea floor of the central eastern Pacific"

(MANOP, 1976:3). Its primary goal is "to develop an understanding of the processes controlling the distribution and composition of deep-sea ferromanganese nodules" (MANOP, 1976:5). An improved ocean bottom monitoring package was developed as the key investigative instrument. Although MANOP was only initiated in 1977 and many findings have not yet been reported, "(p)reliminary results suggest considerable vertical migration of dissolved manganese and iron, as well as other transition metals" (NSF, 1978:67).

MANOP is being conducted by a team of 21 principal investigators from 10 academic/research institutions in the United States. It is significantly larger than the original Manganese Nodules. As in the past, international cooperation remains an important aspect of the project, but no joint research endeavors with foreign scientists are envisaged, as the foreign programs are oriented towards regional studies in contrast to the ocean bottom monitoring emphasis of MANOP.

The management structure of the MANOP project is significantly more formal and complex than the system used in the original Manganese Nodules Project. G. Ross Heath, MANOP Director, observed in an interview with the author that the MANOP designers borrowed extensively from the management systems developed by other successful IDOE projects (Heath, 1978).

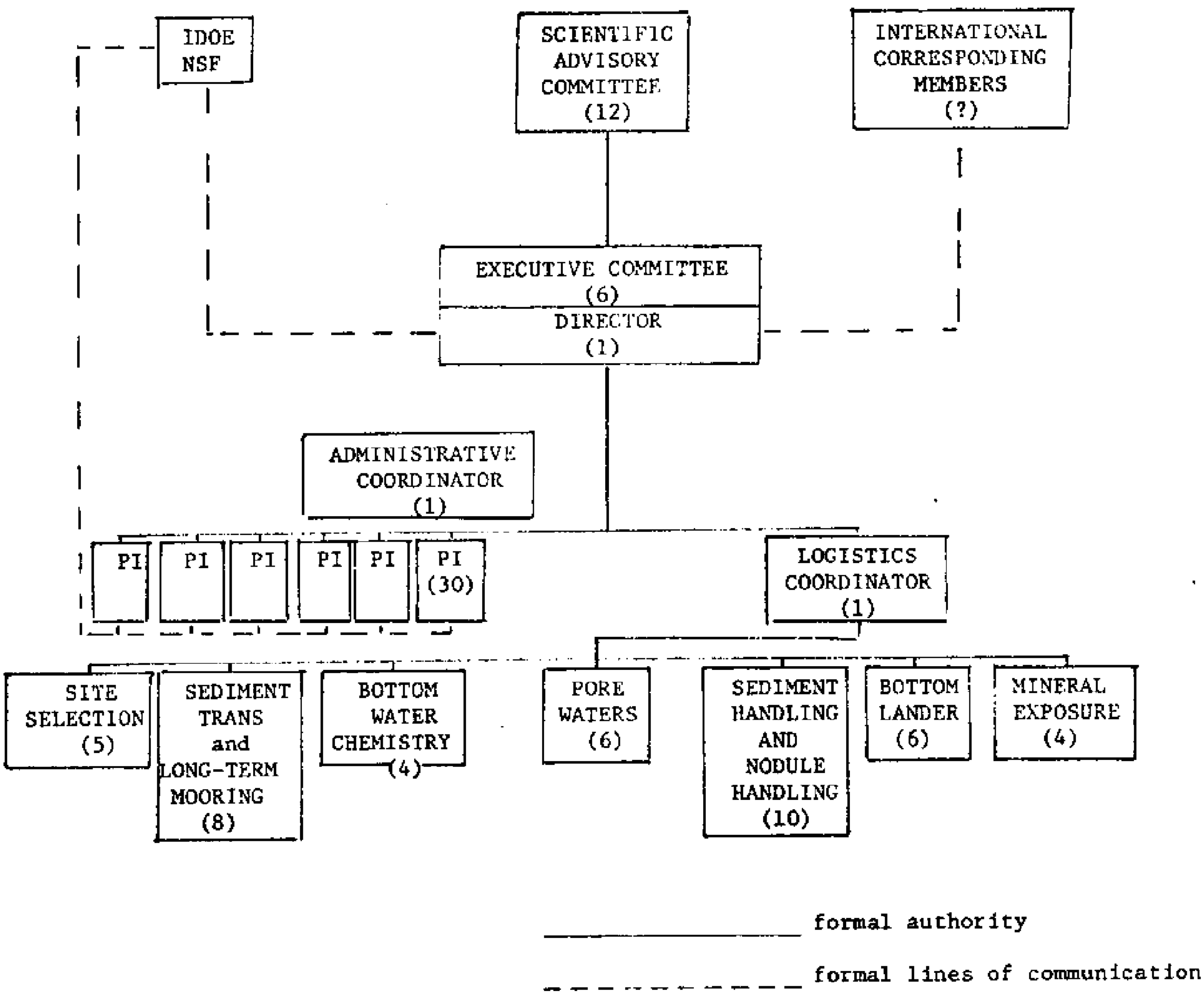

FIGURE 18. MANOP ORGANIZATIONAL STRUCTURE

At the broadest level of authority is the Scientific Advisory Committee, composed of most of the current PI's, as well as several outsiders not funded by IDOE for MANOP related research. "The Scientific Advisory Committee is responsible for establishing the broad research plan," and reviews proposals (Manganese Nodule Program, 1976:98). The MANOP Director acts as Chairman of the Committee, but the 1976 MANOP proposal suggested that once MANOP becomes a functioning entity the Director should resign as Chairman.

The Executive Committee operates at the next level of authority. The Executive Committee is

> responsible for policy decisions during each phase of the program and for implementing long range policy outlined by the Scientific Advisory Committee. It decides on scientific strategy and plans milestones for the programs; serves as mediator if areas of conflict arise within the program; maintains high scientific standards of publication and ensures that all participants receive full credit for their contributions by serving as the clearing house for papers written by MANOP members; oversees and participates in Proposal preparation; aids in the dissemination of MANOP goals and scientific results by participating in a broad spectrum of meetings; and generally encourages communication both within and outside the program (Manganese Nodule Program, 1976:96,98).

Members of the Executive Committee are automatically members of the Scientific Advisory Council.

The Director is responsible to the Executive Committee. It is his responsibility to oversee the scientific program on a day-to-day basis. He is also responsible to IDOE for the progress of the program and serves as IDOE's point of contact on scientific questions. The Director is chairman of the Executive Committee and also of the Scientific Advisory Committee, although the latter role is being phased out and assumed by another member of the team.

An Administrative Assistant, a trained oceanographer, has been assigned to work with the Director and the Executive Committee to handle internal communications within MANOP, data and sample management, arranging cruise travel, and organizing committee meetings. He is also responsible to IDOE for the management aspects of the program, and generally serves as the Director's deputy (Manganese Nodule Program, 1976:100). The Administrative Assistant serves as an _ex officio_ member of the Executive Committee (Manganese Nodule Program, 1976:100).

The Operations Coordinator is a key member of the team serving under the authority of the Director. He is responsible for construction of all equipment and logistical details. He also serves as an _ex officio_ member of the Executive Committee (Manganese Nodule Program, 1976:99).

Several Task Groups have been organized under the authority of the Executive Committee, but get their technical and logistical support from the Operations and Administrative Coordinators (Manganese Nodule Program, 1976:100). The Task Groups are composed of the major principal investigator in the study and represent the integrated, substantive aspects of the project; the constituent elements that make the project more significant than the independent investigations of the PI's.

As in all the other IDOE funded projects, the PI's are supported directly by IDOE Office through their home institutions, and are subject to NSF-IDOE evaluation procedures.

MANOP was not evaluated in the Harbridge House Study. Fellow oceanographers, however, have acclaimed the research as successful and of high quality, maintaining that it has begun to attack many of the most fundamental questions regarding the processes of nodule development.

ANALYSIS

It was argued at the outset of IDOE that it would make a unique contribution to the national marine science program in several ways. First, it represented the first major international marine science endeavor since the International Geophysical Year and the International Indian Ocean Expedition. Unlike the earlier efforts, though, which were primarily national programs with international sharing of plans and data, the IDOE was to attempt to develop truly international projects. Second, "it represent(ed) an instance of governmental initiative in defining a broad area in which scientific knowledge (was) needed for long term practical purposes..." Third, "it (was) specifically designed to fund and manage large projects - projects that involv(ed) investigators from more than one institution and sometimes more than one country - in a way that, by utilizing existing resources and capabilities, diminish(ed) the need for additional capital expenditures and the creation of new permanent institutions" (NACOA, 1975:8).

These in depth descriptions of six IDOE projects make it obvious that IDOE has contributed a new dimension to the national marine science program, but its uniqueness has been compromised by numerous factors. In general, IDOE has been considerably less international, less directed toward practical problems and less large scale than originally envisaged.

International Theme. There are several interrelated reasons for the weaknesses in the international component. One is that the international community has not injected new financial resources into their own IDOEs comparable to the U.S. effort. Second, IOC members, particularly the lesser developed countries, do not believe that the kind of research being conducted under IDOE auspices can be of any significant value to their immediate needs. Third, a changing international political situation has tied up consideration of a new ocean regime in the Law of the Sea Conferences and obviated the immediacy of the IDOE (Galey, 1973:ch. 4). Fourth, the expense involved in making arrangements for international projects and conducting scientific meetings that are required to integrate the data is extremely high and scientists would much prefer to spend the money on the science itself. Finally, cross national efforts often lack flexibility. "They cannot easily redirect their activities, for changes can compromise vast networks of commitments" (Sayles and Chandler, 1971:122). This is particularly the case in countries where the scientists are constrained from making decisions independent from government control.

Nevertheless, the U.S. IDOE program has proceeded with several projects that demonstrate varying levels of international collaboration. Some IDOE projects have required vast field components and have carried them out with an integration of international personnel and hardware. Other projects have utilized international collaboration in the data analysis stage of the research. Most projects supported by the U.S. IDOE program, however, demonstrate only token international involvement or none at all.

Among the projects with major international field components are the French-American Mid-Ocean Undersea Study (FAMOUS), the Soviet-American POLYMODE project (described in an earlier section of this chapter), the Coastal Upwelling Ecosystems Analysis (CUEA) project, the International Southern Ocean Study (ISOS), and Studies in East Asia Tectonics and Resources (SEATAR) (NSF, 1977). The information reported through the IDOE Office as indicated below does not make these distinctions.

TABLE 14

PARTICIPATION BY OTHER NATIONS IN U.S.-LED IDOE PROGRAMS

	GEOSECS	MODE	NORPAX	CLIMAP	SE ATLANTIC MARGINS	NAZCA PLATE	MID-ATLANTIC RIDGE	MANGANESE NODULES	CUEA	SW ATLANTIC MARGINS	POLLUTANT TRANSFER	CEPEX
Argentina					x					x		
Australia			x									
Belgium	x											
Bolivia						x						
Brazil					x					x		
Canada	x		x				x		x			x
Chile						x						
China, Republic of			x		x							
Columbia						x						
Denmark				x								
Ecuador			x			x						
France	x	x	x	x	x		x	x	x			
Germany, Dem.Rep.of									x			
Germany,Fed.Rep.of	x	x	x	x	x			x	x			
Ghana					x				x			
Guatemala					x							
Iceland							x					
India	x											
Israel					x							
Italy	x											
Jamaica					x							
Japan	x		x	x				x				
Mauritania									x			
Morocco									x			
Netherlands				x								
New Zealand			x					x				
Norway				x					x			
Peru						x						
Portugal					x		x					
Senegal					x				x			
Spain					x				x			
Sweden		x										
Switzerland				x								
Union of South Africa					x							
United Kingdom	x	x	x	x	x		x		x		x	x
U.S.S.R.												

Sourc: National Advisory Committee on Oceans and Atmosphere, The International Decade of Ocean Exploration: A Mid-Term Review, A Report for the Director of the National Science Foundation, Washington, D.C., 1975 p. 37.

CEPEX might also be included in the list, but the semi-permanent nature of its field station is distinct. CEPEX utilized Canadian technical assistance at the field station, and scientific collaboration with scientists from Canada and the United Kingdom.

Directed Scientific Research on"Long-term Practical Problems". The potential utility of most IDOE projects on problems of marine resources and environmental protection is best measured in decades or longer. Although there were attempts to give IDOE more social relevance when the program was being planned and later when it was initiated, it has settled into a pattern of basic science support. When it was first defended in Congress, attempts were made to tie IDOE research to issues of the moment. In a statement to the Subcommittee on Science, Research, and Development, for example, Dr. Thomas Owen maintained that the benefits of the Environmental Quality program

> will be the identification of safe rates of waste disposal in the oceans; a means of monitoring the degree of oceanic pollution by man; identification of situations where pollution tolerance levels are being exceeded; a degree of protection of living marine materials; and protection of the consumer from toxic marine products.

With respect to the Environmental Forecasting projects he contended that:

> It is anticipated that the results of such

> studies will provide improved extended forecasts of weather over the eastern North Pacific and North America. They will affect planning in farming, construction, transportation, and marine activities; permit better estimates of pollutant dispersal; lead to improved fisheries prediction and more accurate forecasting of advantageous shipping routes; enhance improved utilization of the oceans as a source of food or as a heat sink for man's activities; and provide a greater ability to calculate water renewal rates in the deep ocean with application to disposal of contaminants, the dispersal of nutrients, and predictive models of global circulation.

The Seabed Assessment studies were to

> provide the regional framework necessary for the assessment of continental margins for their resource potential; the regional data for assessment of seabed areas needed in future law of the sea discussions; the assessment of the economic potential of mid-oceanic ridge mineral deposits and an insight into defining the scope of effort required for exploration and exploitation of such resources, and the assessment of oceanic trenches as sites for possible waste disposal and as sources for valuable minerals (Owen, 1971:V.S-1-1 and 1-2).

Statements by Owen's successors have emphasized the NSF commitment to the support of high-quality basic research (Slaughter, 1978:2-9).

In 1975 NSF authorized an independent evaluation of the IDOE program (NSF, 1975b). One aspect of the evaluation was an assessment of "the degree to which the outputs and results of IDOE projects have contributed or have the potential for contributing to the improvement of environmental quality, environmental forecasting, and management of living and material resources in the oceans" (Harbridge House, 1976: III-1).

Of the twelve projects reviewed by the Harbridge House team of experts, seven were ranked as having low utility or potential utility, two were ranked at the moderate level, two were ranked high, and one "potentially useful" (Harbridge House, 1976).

Large Scale. A large scale project is distinguished from a small scale one on the basis of several criteria that must be measured in degrees rather than absolutes. Most observers would agree, however, that the U.S. IDOE sponsored program supports large scale oceanography. The projects it finances are certainly distinct from those funded by the Oceanography Section.

All IDOE projects have involved teams of scientists, usually with interdisciplinary backgrounds and most often from several institutions. International investigations are less frequent.

IDOE sponsored research projects have often been able to develop new instrumentation, unlike most other-agency supported research. Dr. Derek Spencer, Associate Director for Research at the Woods Hole Oceanographic Institution,

TABLE 15

HARBRIDGE HOUSE EVALUATION
OF USEFULNESS OF IDOE PROJECTS

Projects	Evaluation
MODE	Low
NORPAX	High
CLIMAP	Low
ISOS	Low
Baseline	Low
Transfer	Moderate
GEOSECS	Potentially Useful
CEPEX	Low
CUEA	Low
Continental Margins	High
Plate Tectonics	Low
Manganese Nodules	Moderate

Source: Harbridge House, An Evaluation of the International Decade of Ocean Exploration. 1976.

and Executive Committee member of GOESECS, claims that IDOE has been the only significant federal funding source in the last 10 years to support equipment improvement (1978). The MANOP project has also received considerable funding to develop its ocean bottom monitor, and of course, the CEPEX Controlled Environmental Ecosystems (CEES) or experimental bags represent a creative use of IDOE equipment development support.

Many of the other IDOE projects have also utilized considerable amounts of sophisticated hardware and ship time because of their deep ocean emphasis; they include GEOSECS, MODE/POLYMODE, and the Eastern Atlantic Continental Margin study.

Most IDOE projects have continued considerably longer than small scale studies. CLIMAP, MODE/POLYMODE, and GEOSECS have all extended over the entire Decade. CEPEX was initiated in the 1973 fiscal year and plans to continue to the end of the Decade, and the Manganese Nodules Project/MANOP began in 1972 and also plans to conclude with the ending of the Decade.

Finally, the scale of the IDOE projects has generally required management structures to oversee everything from the conduct of the research to fair and equitable publication of projects' findings. But, as with the other large scale elements, the management structures have varied considerably in size, formality, and quality. The MODE/POLYMODE project and MANOP, among those detailed above, have utilized rather sophisticated management structures that employed oceanographers in full-time administrative duties. CLIMAP and CEPEX have required considerable coordinating expertise, but have not utilized oceanographic personnel in administrative roles. GEOSECS and the Eastern Atlantic Continental Margin study have minimized administrative duties altogether.

The elaborateness of the management structures is a function of three interrelated factors: the complexity of the scientific task, the degree of collaboration and cooperation required among participating scientists, and the personalities of the leading scientists. As stated above, the GEOSECS Executive Committee prefers to delegate very little to an administrative officer. The leaders of MODE/POLYMODE on the other hand have been willing to bring an oceanographer into an administrative role to handle considerably delicate chores.

A fourth factor, unrelated to the first three, that has affected the size and sophisticated of management plans, is the date the project was initiated. As the IDOE program officers have learned how to oversee the management of large scale projects, they have acquired an understanding of the kinds of management structures that have worked successfully. Therefore, projects such as MANOP, which was initiated in 1977, can look back on six years of IDOE experience and assistance in developing a management scheme that leaves control of the science in the hands of the scientists, but which also works well for IDOE administrative purposes.

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CHAPTER V

PROGRAM EVALUATION AND INSTITUTIONALIZATION

INTRODUCTION

Between 1950 and 1977 the federal civilian bureaucracy expanded from about 2 million to 3 million employees. During the same period federal non-military budget outlays increased from $25 billion to $285 billion (U. S. Bureau of the Census, 1978). Despite the massive growth, few mechanisms existed or were used until the 1970's to evaluate bureaucratic performance. In the past few years, program evaluations have become an integral part of federal bureaucratic operations. Evaluations are "relatively structured, systematic analyses of operating programs designed to assess their impact or effectiveness in attaining their stated objectives, or to assess their efficiency" (Lewis and Zarb, 1974:308).

Evaluations have evolved only recently into reliable policy-making instruments. However, some public programs still defy effective evaluation, particularly when they have conflicting or poorly defined goals, or when the assumptions linking program intervention with immediate outcomes or ultimate impacts are not clearly understood or specified (Horst, *et al.*, 1974:300-308).

Evaluations of basic research programs are particularly problematic, because their results and impacts cannot be specified in the short run. But it is "possible to monitor and assess changes in the quality and quantity of research output and relate these changes to changes in the level of funding, characteristics of grantees, and to the mix of manpower and facilities utilized in support of research programs" (NSF, 1975c:6).

IDOE has been the subject of several evaluations or reviews by NSF, NACOA, NAS-NAE, and Harbridge House, Inc., a private consulting organization. The following chapter analyzes the evaluations for their methodologies, conclusions, and, in the cases of NAS-NAE and NSF, for their self-interest. The chapter concludes with an examination of internal NSF and external clientele efforts to determine whether to support a successor to IDOE, or a program similar to it, in the federal bureaucracy.

IDOE GOALS

It is helpful to review the IDOE goals as the yardsticks upon which evaluations have been, or should have been based. As observed in chapter 4, Vice President Agnew announced the establishment of IDOE on October 19, 1969, and identified six goals for the Decade. They were to:

> 1. Preserve the ocean environment by accelerating scientific observations of the natural state of the ocean and its interactions with the coastal margin--to provide a basis for (a) assessing and

predicting man-induced and natural modifications of the character of the oceans; (b) identifying damaging or irreversible effects of waste disposal at sea; and (c) comprehending the interaction of various levels of marine life to prevent depletion or extinction of valuable species as a result of man's activities.

2. Improve environmental forecasting to reduce hazards to life and property and permit more efficient use of marine resources--by improving physical and mathematical models of the ocean and atmosphere which will provide the basis for increased accuracy, timeliness, and geographic precision of environmental forecasts.

3. Expand seabed assessment activities to permit better management--domestically and internationally--of ocean mineral exploration and exploitation by acquiring needed knowledge of seabed topography, structure, physical and dynamic properties, and resource potential;

4. Develop an ocean monitoring system to facilicate prediction of oceanographic and atmospheric conditions--through design and deployment of oceanographic data buoys and other remote sensing platforms;

5. Improve worldwide date exchange through modernizing and standardizing national and international marine data collection, processing, and distribution;

6. Accelerate Decade planning to increase opportunities for international sharing of responsibilities and costs for ocean exploration, and to assure better use of limited exploration capabilities (Marine Sciences Council, 1970:195-196).

The six goals identified by the Vice President drew upon more than three years of planning by scientists and government officials, and were to be used as the starting point in the

Foundation's development of a management plan.

A year later, in a presentation to the American Oceanic Organization, Feenan Jennings, IDOE Head, announced that his office would pursue the first three scientific goals through support of specific high quality basic scientific projects in these areas. At that time he disclaimed responsibility for the broadly stated support functions identified by the Vice President. Jennings argued that the level of funding available to the program did not permit the support of technological development in the general sense (i.e. development of an ocean monitoring system); it could be funded only as it related to those specific research projects supported by the IDOE office. In the same vein he maintained that funding limitations prohibited support of a full-scale modernization and standardization of data exchange systems, but that IDOE projects would be required to submit data to the National Data Centers in a format acceptable to the Centers. In addition, he stated that international cooperation would not be required for support, but that it would be encouraged on an informal scientist-to-scientist basis. IDOE would also press for internationalization through the UN's IOC, and the sponsorship of international workshops (NSF, 1973d:49-52; NACOA, 1975, 36-39).

Subsequently, Jennings and the IDOE implemented a fourth research program "to provide a scientific foundation for better management and use of the ocean's biological resources", a program that was suggested in earlier planning reports but initially was excluded by Agnew and NSF at the establishment of the IDOE office (NSF, 1973b:24).

The goals were to be reached through a scientific approach best described in An Oceanic Quest as a series of "long term and continuing investigations of cooperative nature, directed toward objectives of widespread interest concerned with more effective utilization of the ocean and its resources" (NAS-NAE, 1969:9). Yet, despite their focus on utilization, "the objectives (were to be) related to exploration and knowledge rather than to the development of techniques for the large scale exploitation of ocean resources...Anticipated benefits (were to be) long term in nature..." (NAS-NAE, 1969:5).

EVALUATING IDOE

NAS-NAE. IDOE has been the subject of several evaluations and/or reviews, each different in purpose and methodological approach. This section of the chapter attempts to describe and analyze the major ones, including the NAS-NAE reviews, the NACOA review, the internal NSF statements, and the Harbridge House evaluation.

The first IDOE evaluation was conducted by an NAS-NAE Planning Panel. It attempted to review the recommendations of the NAS-NAE report, An Oceanic Quest. "Of particular concern were the recommendations on funding and the concept of relating the U.S.-IDOE program scope to the recognition of the governmental decision to limit (by definition) the U.S.-

IDOE program to that supported by the NSF-IDOE budget line item" (NAS-NAE, 1970:Preface).

The authors of An Oceanic Quest had recommended that "if much less than $100 million of new money per year (averaged over the Decade) can be made available for the U.S. program of ocean exploration...it would be undesirable to identify the set of programs as an International Decade of Ocean Exploration" (NAS-NAE 1969:87). The Panel recognized that the earlier funding request was inappropriate in light of the redefinition of IDOE to comprise only those projects funded by NSF, and accepted the new concept. It recommended, however, that the NSF-IDOE funding level be increased to accommodate several more considerations that were important to the group.

The Panel suggested, first, that the needs of the developing countries be given adequate consideration in the construction of the Decade. It was the panel's view that "(t)he developing countries envision the results of ocean exploration and research as working only to the advantage of technically developed nations" (Galey, 1973:22; NAS-NAE, 1970:1). Another recommendation placed a greater emphasis on the collection of information relating to seabed minerals, oceanic pollution, and living resources. The final recommendation suggested that equipment development be tied to specific research projects and not considered apart from them. The report concluded with a criticism of NSF's apparent unwillingness to accept "lead agency" responsibility for coordinating all IDOE-LEPOR related projects (NAS-NAE, 1970:1-4).

The planning Panel report, International Decade of Ocean Exploration: A Current Evaluation, was an evaluation in only the loosest sense of the world. The Panel, eight out of whom were on the NAS-NAE Steering Committee that was responsible for writing An Oceanic Quest, took this opportunity to identify its own position on the Decade in the light of the program's redefinition and reduction to a line item in the NSF budget. The Panel's support of the developing nations and the need for additional baseline information in some areas, and its reluctance to support general equipment development, all reflect fundamental scientific self interests. For example, by supporting greater participation by the developing nations the scientists hoped to maintain access, for research purposes, to the coastal waters of those nations; the need for baseline information was perceived as a prerequisite to meaningful basic investigations; and the reluctance to support general equipment development meant less money for separate engineering enterprises and more for scientific investigations.

The IDOE Office accepted and implemented the NAS-NAE assessment on scientific priorities and even attempted to increase the participation of developing nations -- the Eastern Atlantic Continental Margin study is a good example -- but IDOE rejected the suggestion of "lead agency" status for the same reasons that the Foundation in 1950 had rejected the opportunity to assume the coordination of the national science program. Jennings recognized that IDOE was in no position to tell other agencies what to do or how to do it. IDOE was not given the authority or the power, in his estimation, to assume lead agency responsibilities. In addition, the Foundation did not wish to become involved with applied scientific undertakings.

Another Joint Ad Hoc Panel of NAS-NAE reviewed selected aspects of the IDOE program in each of the first three years of its operation (NAS-NAE, 1972; 1973). The Joint Ad Hoc Panel was composed of fifteen members; six of those fifteen also served on the Planning Panel and the Quest Steering Committee. The Joint Ad Hoc Panel made no attempt to evaluate the science projects directly, but was more interested in the program's general scientific directions, administrative oversight procedures, findings, and international component.

The Panel's recommendations were based on a description of the IDOE program by IDOE officials and observations of the IDOE mode of operation. Several members of the group were already familiar with IDOE from their participation on the Quest Steering Committee and the NAS-NAE Planning Panel.

In general, the Joint Ad Hoc Panel reports indicated satisfaction with the scientific directions, particularly after the addition of the Living Resources Program; approval of administrative oversight procedures, although they stipulated the need for periodic review to guarantee quality control, and recommended less discretionary authority for IDOE staff in selection of preliminary proposals; concern that more consideration be given within the Foundation at the "proper" distribution of funds for large scale and small scale oceanography in order that small scale research not be overrun by the newer mode; and approval of the strengthening of the international component by the addition of staff to handle problems raised by international cooperative science, and by the initiation of foreign-supported IDOE projects.

the NAS-NAE panels traditionally have been weighted heavily in favor of academic basic science and the administrative procedures that best accommodate it. The recommendations of the Joint Ad Hoc Review Panels reiterated their basic science concerns, particularly the recommendations to minimize the discretionary authority of the IDOE officials in the proposal selection process and to emphasize the need for periodic scientific review. Academic oceanography had traditionally been a small-scale enterprise, and the Joint Ad Hoc Panel wanted to stress the need to maintain a high level of support for small scale projects. This attitude is reinforced by the University of Connecticut survey findings, which suggested that academic marine scientists were considerably more disposed to increasing support for small scale investigations than for large scale projects. When asked, "If Federal support for academic marine science were to be increased by 50% in dollars of constant purchasing power over the next five years, where would you like to see the money applied?" 58.2 percent indicated greatly increased funding for "small" grants for basic research", compared to only 14.2 percent for "large scale projects, basic research".

Finally, as in the Planning Panel report, the Joint Ad Hoc Panel report expressed approval of IDOE efforts to strengthen the international program as a way of fostering foreign participation and, it was hoped, retaining American scientific access to the coastal waters of participating nations.

NACOA. In 1975, the National Advisory Committee on Oceans and Atmosphere (NACOA) conducted a "Mid-Term Review". NACOA, composed at that time of a blue ribbon committee of twenty-five members drawn from the non-federal community covering a wide range of marine and atmospheric interests, was asked "by the Director of the National Science Foundation to review the International Decade of Ocean Exploration... and to make recommendations regarding its future" (NACOA, 1975:v).

> The Director asked NACOA to 'review the scientific, budgetary, and managerial aspects of the program, and more generally, IDOE's compatibility with national priorities in marine and atmospheric sciences'. He also identified certain issues and questions as indicative of the scope and flavor desired in this review - these were:
>
> 1. The responsiveness of IDOE to the 1969 guidelines under which it was established.

> 2. The current validity of the guidelines as expressions of national and international needs in marine science.
>
> 3. The effectiveness of large, directed research projects in addressing the problems posed by the original guidelines.
>
> 4. Whether IDOE findings to date have been of high scientific quality and have contributed to national and international social, economic, and political objectives.
>
> 5. Given the national termination date of 1980, what recommendations would NACOA make about the future of IDOE (NACOA, 1975:v-vi)?

NACOA established a seven-person panel and a staff of four to conduct the review. "In conducting its review, the NACOA panel drew upon published and unpublished IDOE reports, briefings by IDOE Office staff and participating scientists, attendance at meetings of various IDOE scientific councils, steering committees, advisory panels, workshops and conferences, and consultation with individuals who have been involved with the IDOE in its early and later stages" (NACOA, 1975:vi).

The findings of the NACOA panel indicated, first, that IDOE had indeed been responsive to the 1969 guidelines announced by Vice President Agnew, within the limits of severe funding constraints, and that in general resources were allocated wisely. It recommended that if more money should become available, that the support goals should be addressed--

development of an ocean monitoring system and improvement of the international competence needed to share the responsibility of ocean exploration. Second, the Panel observed that the guidelines still served as valid expressions of national and international needs in marine science. Third, the large scale approach, according to the Panel, had been effective and had enabled oceanographers to address problems that could not have been addressed by conventional small projects. Finally, the panel recommended the termination of IDOE in 1980 because "its stated purpose -- a decade of concentrated effort to make a start toward acquiring the needed understanding of the oceans -- will have been accomplished" (NACOA, 1975:20). It added, however, that a framework should be maintained to continue the kind of work being done by IDOE (NACOA, 1975:21).

No attempt was made by the panel to assess the scientific quality of the IDOE program because the members erroneously believed that this area was being addressed by internal NSF mechanisms and by the NAS-NAE. The panel did suggest, however that "more could and should be done to enhance the prospect of increased public benefit from IDOE activities" (NACOA, 1975:20).

The NACOA panel went beyond its mandate and made seven additional recommendations, the first three of which related to meeting the needs of the future; the last four concerned the remainder of the Decade. They included:

1. The function of providing support for long-term multi-institutional, multi-disciplinary studies of the oceans is an essential one that should be kept intact.

2. The funds presently allocated to long-term cooperative ocean studies should not be lost when the decade ends.

3. NSF and the scientific community should start getting organized for the work that is to follow when the decade ends.

4. There should be a concerted effort to encourage greater international cooperation in ocean research, with special emphasis on fostering the growth of oceanographic competence in the developing coastal nations.

5. There should be increased emphasis on assuring realization of the practical implications of ongoing and planned IDOE research.

6. The IDOE Office should seek ways to support individual scientists wishing to participate in IDOE projects of other nations, should make an effort to develop suitable vehicles for reporting and publicizing technology developed in IDOE projects, and should be more flexible in considering research proposals which include landward aspects of the oceanic processes being studied in ongoing IDOE projects.

7. New projects should continue to be taken on as the decade progresses (NACOA, 1975:21-24).

The NACOA Mid-term Review of IDOE was not considered by NSF to be an evaluation in the strict sense of the word any more than were the NAS-NAE reviews. In fact, the NSF Office of Audit and Oversight overlooked NACOA's evaluation of past progress and viewed the study more as a prescription for future directions (Abel, 1977). In addition, the NACOA study, as with the NAS-NAE reviews of IDOE, failed to examine the scientific progress that the IDOE projects were making toward their objectives. They were more concerned with general scientific directions and procedural matters.

NSF. NSF also conducts internal program reviews at several levels. At the highest level of the Foundation, the National Science Board Programs Committee is required by statute to evaluate all projects with funding commitments that exceed $500,000 per year or $2,000,000 for their duration. "This examination is exhaustive and intensive with special documentation prepared to justify each proposed commitment. Evaluation of the results of projects proposed for continuation is a major emphasis, with attention devoted to the scientific merit of the project, the distribution of needed resources and the value to science and the nation of the result to date, and anticipated future results" (NSF, 1975c:3-4). Most IDOE projects must pass through this process at least once during their lifetime. IDOE projects have experienced a great deal of trouble with NSB evaluations. The Board has been particularly critical of the quality of the IDOE research proposals (Botzum, 1979:1). In addition, a general belief pervades the Foundation and scientific community that the Board prefers small scale science to large. According to the Ocean Science News, "the emphasis of the board, under the Carter Administration, has been to move away from large projects" (Botzum, 1979:1).

At the next level the Program Review office in the Office of Planning and Resources Management "is responsible for providing reviews and critical examination of the Foundation's programs... These formal program reviews provide the Director... (with) a candid appraisal of substantive program content, management organization and major trends and problems of management concern and interest" (NSF, 1975c:4). Each program is reviewed approximately once per year. In actual fact, the Director's Program Reviews are descriptive reports with no obvious evaluative components, and in many respects they are not significantly different than the annual IDOE Progress Reports, although they occasionally include actual and projected financial information which is not in the Progress Reports.

Finally, the Office of Audit and Oversight conducts audits to review the financial and related management aspects of NSF grants and contracts with outside institutions, as well as program result audits which evaluate program impact. These audits are contracted to outside organizations.

Harbridge House. In March 1975 the Office of Audit and Oversight issued a request for proposals (RFP) to evaluate the principal results and impacts of the IDOE. The objectives of the evaluation were to

> (a) determine the progress that each IDOE project has made in accomplishing the project objectives, and (b)

> assess the degree to which the outputs and results of IDOE projects have contributed or have the potential to contributing to improving environmental quality, forecasting and management of living and material resources in the ocean (NSF, 1975b:1).

The RFP was in direct response to Congressional dissatisfaction with the lack of evaluations being conducted by NSF (NSF, 1975c). IDOE was selected because Senator William Proxmire had expressed a personal interest in the program (Abel, 1977).

The RFP identified the evaluation tasks as, first, to quantify the statements of project objectives to the maximum extent feasible, and second, to develop appropriate criteria and measures for

> 1. assessing the extent to which objectives have been met by comparison of products and results with objectives,
>
> 2. assessing the actual or potential impacts of the project results and products on environmental quality, forecasting and management of living and material ocean resources,
>
> 3. comparing the results and outputs of IDOE projects with a sample of oceanographic grants from a non-IDOE program (NSF, 1975b, Enclose 1:5).

The Harbridge House, Inc., was awarded the contract over three competitors on the basis of its superior quantitative approach to the task.

> ...Harbridge House proposed to conduct an evaluation, employing university

> faculty and students as evaluators, that would use the research findings, as described in the literature, in measuring the progress each IDOE project had made toward its objectives and in assessing the contributions each had made toward program goals. Also proposed, as a measure of the scientific results described in IDOE publications, was the use of the frequency and the type of the citations of the IDOE publications.
>
> To provide a comparison, or a "Control", for the measured progress of IDOE projects toward their objectives, Harbridge House proposed to use other oceanographic projects that were comparable to the IDOE projects in objectives and scope, but funded and administered entirely from outside the IDOE Program. The purpose of comparing the progress of IDOE research with that of the Control research was to obtain an assessment of the effects of large-scale organization (such as the IDOE Program), as opposed to more individualized efforts under conventional grants, on scientific research (Harbridge House, 1976:III-1-2).

Problems with the methodology surfaced immediately. First, the IDOE literature was sparse overall because many of the projects were still primarily involved with collection or analysis of the data and had not yet arrived at the publication stage, or if they had, the literature was not complete and an accurate count could not be obtained with the use of the Science Citation Index. Second, in many cases it was impossible to obtain adequate control information. Where IDOE-control comparisons of citations were made, analyses were often unfair because most IDOE projects were ongoing or only recently completed and publications were not abundant. "The results of the (citation) evaluation indicated that there was indeed a difference between the IDOE and the control publications, but because of such factors as sample sizes and research timing, little significance, in terms of scientific merit, could be ascribed to these differences" (Harbridge House, 1976:III-3). Thus, much of the quantitative component of the evaluation was unsuccessful.

More reliance had to be placed on the subjective component of the evaluation. Scientific teams--oceanographers drawn from the faculties and graduate students at leading U.S. universities--analyzed the publications and unpublished reports, and conducted interviews with IDOE-supported scientists to assess the content, progress, quality, synthesis, and utility of the respective projects. A listing of the individuals interviewed in each of the program areas suggests that the evaluators relied on the opinions of a very small number of IDOE participants, and for many projects no scientists were interviewed. Twelve participants in Environmental Quality projects were interviewed, 21 in Environmental Forecasting, 9 in Seabed Assessment, and only 5 in Living Resources (Harbridge House, 1976:Appendix E).

Each IDOE project (14 at the time) was evaluated for progress toward objectives, the degree of synthesis involved in achieving project results, its large scale uniqueness, scientific quality, and utilization potential. Because the quantitative component of the evaluation achieved such limited results, Harbridge House concluded the section of its report on

"Evaluation Scope and Approach" with the caveat that"...the reader of this evaluation should keep in mind that the conclusions are drawn from subjective judgments about the significance of findings from investigation samples" (Harbridge House, 1976:III-9).

In general, Harbridge House concluded that there was great variability throughout the IDOE programs in terms of each of the evaluation criteria. The reviewers were particularly critical of the level of synthesis taking place within the projects. That is, despite their ostensible large scale, broad scope concerns, there was little effort among scientists to cooperate and resolve the broad questions. In addition, the report was also critical of the social utilization potential of most of the IDOE projects; it considered most of the projects basic oriented and not responsive to social concerns.

The Summary evaluations of the six IDOE projects identified in the last chapter are presented here in tabular form. (See Table 16.).

The IDOE staff considered the overall Harbridge House evaluation devastating, although some projects were given generally high grades. The NSF hierarchy was also shocked by the findings, considered them misleading, and has unofficially attempted to limit access to the report. The chief criticisms of the report, as expressed by the IDOE

TABLE 16

HARBRIDGE HOUSE
SUMMARY EVALUATIONS
OF SIX SELECTED
IDOE PROJECTS

Evaluation Measures	PROJECTS					
	MODE	CLIMAP	GEOSECS	CEPEX	CONT. MARGIN	MANG. NODULE
Progress	Moderate	Substantial	Substantial	Little	Substantial	Little
Synthesis	Low	High	High	Low	Moderate	Low
Quality	High	High	High	Average	Average	Low
Uniqueness	Yes	Yes	Yes	Yes	Yes	No
Utility	Low	Low	Potentially Useful	Low	High	Moderate

Source: Harbridge House, Inc., Evaluation of the International Decade of Ocean Exploration, 1976, ch. 4.

Head, were that although the quantitative approach proved useless to the evaluators, that was, in fact, the basis used for many of the findings. In addition, there was not enough interviewing of pariticpating scientists, and very little interaction with IDOE staff (Jennings, 1977)

INSTITUTIONALIZING IDOE

The U.S. IDOE program was established in 1969 as "a Decade of intensified international collaboration to plan, develop, and carry out programs to increase understanding of the ocean and its mineral and living resources" (Marine Sciences Council, 1969:1). As the Decade has approached its objectives and termination date, several studies have been undertaken to consider its continuation, for it is a maxim of public organizations that they rarely terminate willingly (Downs, 1967:22-23).

NACOA. A major aspect of the NACOA report, The International Decade of Ocean Exploration: A Mid-Term Review, was its recommendations for the future of IDOE. Although the NACOA team suggested that the IDOE program itself be terminated, it proposed that a replacement for the type of research supported by IDOE should be implemented.

The NACOA team suggested that there were plenty of large scale, multi-disciplinary problems calling for study and that "perhaps an Office of Ocean Explorations within the NSF should be established on a continuing basis" (NACOA 1975:21). They added that the IDOE had been handicapped by the level funding, but that the funds should continue to be earmarked for IDOE-type research. Finally, they recommended that IDOE should initiate a "process of identifying goals and guidelines" for a post-IDOE program (NACOA, 1975:22). In this regard, they suggested that the post-IDOE program not be limited strictly to the oceans when the problems may lead them to land, that they coodinate their activities closely with ongoing programs in related areas, and that the international projects not always be large scale and beyond the capacity of smaller nations to participate (NACOA, 1975:22-23).

NAS-NAE. In February 1977, NSF requested the aid of the National Academy of Sciences to assist in the planning of a series of workshops to consider the issue of a post-IDOE program, and subsequently to prepare a report based on the workshops' deliberations (NAS, 1978:iii). NAS appointed a Steering Committee, chaired by Dr. Warren Wooster, to assist the Foundation. Four disciplinary workshops were held to identify problems that marked the most promising directions for research. A fifth workshop discussed the prospective management and international aspects of the proposed post-IDOE program. The results of the workshops were published by the Center for Ocean Management Studies at the University of Rhode Island, August 1977, in the one-volume report, Ocean Research in the 1980's, Recommendations from a Series of Workshops on Promising Opportunities in Large Scale Oceanographic Research.

A summary workshop was organized by the Steering Committee in September 1977 to review the Rhode Island suggestions and further probe the research needs and opportunities of large scale investigations for the 1980's.

The Steering Committee used all of these materials in preparing its report, The Continuing Quest, which was published one year later in September 1978. The report contained 28 specific recommendations on program outlines, organization and management, cooperative arrangements, and support requirements.

The program outlined by the Steering Committee essentially recommended a continuation of the IDOE, emphasizing long-term, interdisciplinary, international research focused on areas of national need. It suggested some modifications, however, including the idea that the post-IDOE program consider funding pilot studies of intermediate size lasting for a year or two, and then either terminate them or develop them into major projects.

The proposed funding level for the new program was estimated by the Commiteee to begin at $45 million in 1980, increasing to approximately $60 million in constant dollars by 1990 (ship operating expenses included). The funding suggestions were based on the recognition of "a higher national priortiy for ocean research" due to the "growing potential for conflict among (its) uses and users... and the urgency for a stronger scientific basis for ocean policy decisions", and due to the extension of national jurisdictions which has resulted in increased oceanographic costs, among other reasons (NAS, 1978:123). The estimated costs for the various post-IDOE program components are presented in the table below.

Table 17

ESTIMATED COSTS OF POST-IDOE PROGRAM
(In constant 1981 million dollars)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
A	25.0	25.8	26.5	27.3	28.1	29.0	29.0	30.7	31.7	32.6
B	2.5	2.6	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3
C	11.0	11.3	11.7	12.0	12.4	12.8	13.1	13.5	13.9	14.4
D	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
E	2.5	2.6	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3
F	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Total	44.9	46.2	47.3	48.6	50.0	51.5	52.9	54.3	55.9	57.9

Source: National Academy of Sciences, The Continuing Quest, 1978, p. 126.

A. Basic program

B. Intermediate and pilot projects

C. Ship operations

D. Ship refit and replacement

E. Equipment replacement and development

F. Additional distant water research costs

In a conversation with the author, Dr. Warren Wooster, he suggested that although the funding request in The Continuing Quest was more realistic than the one in the original Quest published ten years earlier, he did not think that, if the program were established at all, its budget would increase significantly from the $15 million to $20 million level of the current IDOE.

The organization and management scheme of the proposed program as recommended by NAS is also similar to IDOE. The Committee suggested, though, that reviews occur at less arbitrary time intervals, and that program administrators take advantage of "natural plateaus" in development.

In addition, the NAS-NAE group suggested that cooperative arrangements in the proposed program should continue in the manner of IDOE at the inter-institutional and international levels. NAS-NAE also recommended that the new program should be located in the Ocean Sciences Division of the Astronomical, Atmospheric, Earth, and Ocean Sciences Directorate, and Effective coordinating devices with other ocean-related research in the Directorate should be developed. A major doubt of the Panel was its belief that the marine science community would find it difficult to locate potential scientific leaders for the large scale projects and talented program managers to administer the IDOE program office.

<u>NSF Reaction</u>. Despite the overall favorable recommendations of both the NACOA and NAS-NAE reports regarding IDOE and the need for a permanent large scale Federal funding source, the Foundation equivocated on the post-IDOE program idea. The NSF hierarchy, particularly the NSB, reiterated the Harbridge House arguments as the basis of their reluctance, which was extremely ironic because the critique focused on IDOE's failure to contribute to "social goals". The Board also criticized the large scale mode of operation, which they considered too difficult to evaluate (Botzum, 1979).

It is extremely difficult to understand the criticism from the NSB relating to IDOE's failure to conduct socially useful research. But, apparently, the Board is "under heavy pressure", presumably from the Executive Office "to produce a 'new order' for ocean science in its budget" (Botzum, 1979). The recent Foundation report that favorably considers the conversion of the <u>Glomar Explorer</u> to a drilling ship may be indicative of the new direction being taken by the Foundation. The report stresses the ship's potential utility in reaching deep ocean mineral and fuel resources (Sullivan, 1979).

An entire administrative - advisory apparatus has been constructed to operate most efficiently with the small scale project system. The OMB has reinforced the small scale leanings of the Foundation in its program recommendations (Botzum, 1979).

Although the final decision regarding the post-IDOE program has not been made as of this writing, there is some indication that large scale oceanographic research will continue to be supported by the Foundation, but that it will not be a separate entity in the Ocean Sciences Division. Rather, it appears that large scale oceanographic research will be incorporated into the Oceanography Section. It is not certain whether a specific distribution of funds will be allotted for small scale and large scale research, or whether a more fluid financial situation will be implemented. It is also uncertain which condition -- allotment of specific funding level or fluid distribution of funds-- would be of greatest benefit to the large scale research approach.

CONCLUSION

> Organizational arrangements are not neutral. We do not organize in a vacuum. Organization is one way of expressing national commitment, influencing program direction, and ordering priorities. Organizational arrangements tend to give some interests, some perspectives, more effective access to those with decision-making authority...
>
> Institutional location and environment, administrative arrangements and type of organization, can raise significant political questions concerning the distribution and balance of power between...the Federal Government and organized interest groups particularly the principal beneficiaries of Federal programs; and...among the components of the executive establishment itself... (Seidman, 1975:14-15).

In the case of IDOE we reviewed and analyzed several organizational and clientele related factors that shaped the program's development and implementation. The channels of government through which the program idea evolved was considered first. IDOE was conceived in the Marine Sciences Council, an organization created by Congress and located in the Executive Office of the President. Its mandate was to coordinate the Federal marine effort which was scattered across the entire bureaucracy. The charge was particularly difficult because of the Council's lack of authority over the major line departments and other marine agencies. Groping for a unique organizational identity the Council seized upon a statement by President Lyndon Johnson -- a call for greater international cooperation in the field of oceanography -- to develop a wide ranging program concept to increase our knowledge of food and mineral resources in the world's oceans. The program idea called for large scale, international cooperative undertakings that would include a broad array of Federal institutional sponsors and scientific interests.

As originally envisioned the IDOE was to be a powerful political tool to forestall consideration of a United Nation's effort to internationalize the sea floor, which would threaten any unilateral U.S. effort to mine it. The origins of the IDOE were, in short, highly political and shaped by the interests of the Council and the President.

Most marine affairs constituencies in the U.S., however, were either not interested or not well organized to help shape the new program idea. Only the scientific community was in a position to influence IDOE directions. However, the marine science community was unwilling to become involved in what it considered to be a "political gimmick" (Vetter, 1978). Instead, they developed an independent report that detailed their principal scientific interests in the areas outlined by the Marine Sciences Council.

Bureaucratic rivalries among participating Council agencies over jurisdictional issues and changes in the international situation -- including movement toward a new Law of the Sea Conference -- which dissipated immediate Presidential interest, brought the singularly unified scientific community the major role in shaping the IDOE concept. At this point the IDOE began a gradual process of devolution; originally designed as a large scale international enterprise with scientific and non-scientific elements, the program was transformed into one more consonant with the routinized expectations of the marine science community. It was reshaped into a program in which all the participants and "ground rules" were familiar.

The decision to place the scientific component, the only funded one, in the National Science Foundation was decisive for the future of IDOE. Since its inception in 1950 the Foundation has stressed its role as a supporter of undirected basic research. It developed a system of operating procedures that maximized the influence of the basic scientific community in the selection of research projects, and an administrative style that guaranteed maximum feasible autonomy to its investigators. the IDOE, still not completely detailed, was thrust into this thoroughly science controlled organizational environment.

Finally established and located in the National Science Foundation, the IDOE adopted a set of administrative arrangements similar to those employed by the other major research components of the Foundation. They called for a system of peer review for proposal evaluation, minimal administrative project oversight, maximum scientific project management control, and periodic evaluation and short-term (6 months to 2 years) funding support. While these arrangements were highly suited to the conduct of basic small scale investigations, they are not entirely suited to the conduct of basic (with long term social applications) large scale endeavors which IDOE was to support. A symbiotic relationship between IDOE and the Foundation developed that has persisted throughout the decade.

In the end it appears that internal bureaucratic difficulties with resolving how to administer and evaluate the large scale projects, and with satisfactorily defining the meaning of basic investigations with long term social applications, have resulted in a decision to terminate the Decade at its conclusion and not replace it with any other unique administrative entity. The failure of the marine science community to rally to the defense of IDOE, arising in part from its own ambivalence toward large scale science was also a crucial factor. The Foundation has maintained, however, that there is a need for large scale approaches to some problems and that they will be addressed through administrative mechanisms already in place.

APPENDIX 1.

LIST OF SCIENTISTS AND ADMINISTRATORS INTERVIEWED

American University
Thomas Owen, former Assistant Director, NSF

Harvard University
Allen Robinson

Lamont-Doherty Geological Observatory
Wallace Broecker
Rose Mary Cline
Sam Gerard
George Kukla
Andrew McIntyre

Massachusetts Institute of Technology
Roger Burns
Robert Heinmiller

National Academy of Sciences
Richard Vetter
R. White, formerly of NOAA and ESSA

National Science Foundation
Robert Abel
Hugh Albers
Roger Baier
Curt Collins
Edward Davin
Dirk Frankenberg
Dean Holt
Mary Johrde
Bruce Malfait
Joan Mitchell
Robert Wall

State University of New York, Stony Brook
J. L. McHugh, formerly of IDOE

University of Rhode Island
Paul Dauphin
G. Ross Heath
John Knauss
Foster Middleton

Texas A & M University
Feenan Jennings, formerly of IDOE
Lauriston King, formerly of IDOE
Worth Nowlin, formerly of IDOE

University of Washington
Edward Wenk, Jr.
Warren Wooster

Woods Hole Oceanographic Institution
K. O. Emery
George Grice
John Ryther
Derek Spencer
Richard Von Herzen
Peter Wiebe

APPENDIX 2.

SCIENTISTS' INTERVIEW SCHEDULE

1. Would you discuss the origins of the scientific project and the initial efforts to bring together a team of scientific and technical personnel?
    a. What was the level of agreement on the main scientific questions?
    b. Who were the original scientific leaders?
    c. Who funded the preliminaries? How, or what form did the support take?

2. How instrumental was the establishment of IDOE to the eventual conduct of this particular large scale project?
    a. Were there other funding options?
    b. Was this project being considered before the establishment of IDOE?

3. When this project was conceived was it an issue that it may not be compatible with IDOE objectives?
    a. What is your opinion on the four principle scientific objectives, or areas of investigation of IDOE?
    b. Do you believe that the four program offices are restrictive or conservative in the interpretation of possible projects within their jurisdictions?

4. Do you believe that the program managers at IDOE (the ones you are familiar with) possess the appropriate scientific training to competently evaluate and administer your project?

5. Are you pleased with the manner in which your project is administered by IDOE?
    a. Is there too much or too little contact with IDOE staff?
    b. Do they ever attempt to impose their judgements on science matters?
    c. What functions does the program manager perform?

6. Would you discuss the differences in the review, funding, and renewal process between large scale and small scale projects?
    a. How would you improve the process?

7. Could your project effectively utilize more funding support?

8. Is the competition among scientists within the project problematic for the conduct of the science?

9. What is the meaning of teamwork and scientific cooperation in this project?

10. Would you explain the administrative functions that must be performed in this project, and to what extent they require the administrator to have a background in oceanography?

11. Would you explain the organization of the project?
    a. How does it facilitate the conduct of the science?
    b. How does it promote interdisciplinary cooperation and collaboration?
    c. How does the Executive Committee function?
    d. What are the responsibilities of the Scientific Advisory Committee?

12. How important is the international component of this project?
    a. To what extent do you cooperate with foreign efforts in this area?
    b. Is there any cooperative science between nations being conducted for this project?
    c. Would more or less be beneficial for the science?
    d. Does an international component to a science project significantly increase administrative, or non-science expenses?
    e. Do the social benefits of international collaboration outweigh the scientific benefits in your opinion?

APPENDIX 3.

IDOE ADMINISTRATORS' INTERVIEW SCHEDULE

1. Would you review for me your educational and administrative background and explain how you believe it prepared you for this type of position?
    a. What are your career plans?

2. What is the background of this program office?
    a. How many previous program managers?
    b. How successful or highly considered by the oceanographic community have been the projects supported by the program office?
    c. How has the program office fared compared to the other 3 in terms of funding, and what are the reasons?
    d. What is the status of the ongoing projects?

3. How is a project initiated?
    a. From where do the original ideas eminate and what are the first organizational responses?

4. Would you comment on the perception of the marine science community that the initial planning and workshop phase of large scale projects is closed?
    a. How democratic should the process be?

5. Are there any agency "pressures" or "incentives" to support research that has more immediate policy implications or utilization potential?
    a. What are the pressures by scientists in the opposite direction?

6. How much competition is there between program offices at IDOE and how does it manifest itsefl?

7. What do you consider to be your primary administrative responsibilities?

8. How much communication is there between the IDOE Office and the project team?

9. How much oversight is there of IDOE projects?
    a. Do scientists find it difficult to adjust to the oversight requirements of large scale science?

10. What is your opinion on the future of large scale science support in the Marine Sciences Division of NSF?

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March 1979

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