Working Together in the EEZ: Final Report of the Committee on Exclusive Economic Zone Information Needs (1992)

Pages
117

Size
8.5 x 10

ISBN
030936177X

Committee on Exclusive Economic Zone Information Needs; Marine Board; Commission on Engineering and Technical Systems; National Research Council

WORKING TOGETHER IN THE EEZ

FINAL REPORT OF THE COMMITTEE ON EXCLUSIVE ECONOMIC ZONE INFORMATION NEEDS

Marine Board
Commission on Engineering and Technical Systems
National Research Council

National Academy Press
Washington, D.C. 1992

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the panel responsible for the report were chosen for their special competencies and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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The program described in this report is supported by Cooperative Agreement No. 14-35-0001-30475 between the Minerals Management Service of the U.S. Department of the Interior and the National Academy of Sciences. The federal agencies that actively supported and participated in the committee's work were the United States Geological Survey and the National Oceanic and Atmospheric Administration.

Limited copies are available from:

Marine Board
Commission on Engineering and Technical Systems
National Research Council
2101 Constitution Avenue
Washington, D.C. 20418

Printed in the United States of America

COMMITTEE ON EXCLUSIVE ECONOMIC ZONE INFORMATION NEEDS

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PREFACE

From the days of discovery and colonization, America has looked to the sea. In times of stress the sea has been our ally, and in times of peace, a source of our prosperity ... How fully and wisely the United states uses the sea in the decades ahead will profoundly affect its security, its economy, its ability to meet increasing demands for food and raw materials, its position and influence in the world community, and the quality of the environment in which its people live. (COMSER, 1969: Our Nation and the Sea: A Plan for National Action).

BACKGROUND

A 1983 presidential proclamation of a U.S. Exclusive Economic Zone (EEZ) (See Appendix A) created a 200 nautical mile-wide belt of jurisdiction over seabed resources adjacent to the United States and its island territories. The proclamation extends U.S. sovereign rights in this region for the purposes of exploring, utilizing, conserving, and managing natural resources. The EEZ contains living resources, such as fisheries, and potential mineral and energy resources. The seabed of the EEZ is presently the site of communications cables, pipelines, oil and gas exploration and production platforms, marine sanctuaries, and may also be suitable in the future as a repository for certain residuals.

Use of the seabed incurs the responsibility of formulating sound development and management policies for this vast area, which fulfill the nation's economic interests, and address concerns about stewardship of the ocean environment. The foundation of wise policies for long-term management of the seabed and its resources is an understanding of its geologic, biologic, chemical, and physical characteristics.

Following a series of exploratory discussions between the Office of Energy and Marine Geology of the U.S. Geological Survey (USGS) and members of the Marine Board of the National Research Council (NRC), a committee was appointed under the NRC's Marine Board in 1986 to identify existing and potential uses of the seabed in the EEZ and assess the adequacy of current research and technology to serve as the basis for planning future utilization. The committee's investigations resulted in a report, *Our Seabed Frontier: Challenges and Choices* (NRC, 1989). A summary of the conclusions and recommendations from this report is found in Appendix C.

> A major conclusion of the 1989 study was that:
> for all foreseeable uses of the EEZ seabed, improved coordination and increased joint planning are needed to implement effective and efficient systematic mapping and surveying programs and develop or improve the technology needed to support them, improve access to and sharing of EEZ data, develop approaches for multiple uses, identify and resolve potential conflicts among various users, and ensure environmental protection. Such a strategy would provide the nation with the foundation for a coherent plan for developing its ocean territory.

In May 1988, the Director of the USGS and the Administrator of the National Oceanic and Atmospheric Administration (NOAA) requested that the Marine Board establish a new committee representing the major nonfederal users of seabed information to identify the needs and priorities of the states, academia, and industry for data and mapping in the EEZ.

Following approval by the NRC's Governing Board, a committee was appointed in June 1989 to perform this task. This is the final report of their three-year study. Two interim reports have been published (NRC 1990, 1991a). Findings from these reports are found in Appendices D and E.

COMMITTEE COMPOSITION AND SCOPE OF THE STUDY

Members of the committee on EEZ Information Needs included representatives from marine industries and oceanographic institutions, experts in marine geology, marine technology systems, marine engineering, marine mining, and geophysical data systems, and a coastal state geologist. Biographies of committee members are found in Appendix B. The principle guiding the committee, consistent with NRC policy, was not to exclude any information, however biased, that might accompany input vital to the study, but to seek balance and fair treatment of all viewpoints.

In accordance with the request from the USGS and NOAA and based on preliminary scoping of the issues at their first meeting, the committee defined the overall objectives for its investigations as follows:

- to ascertain user requirements and priorities for information within the nonfederal community, including the states, academia, and industry;
- to assess the technical aspects of the national program for EEZ seabed mapping and research, with special attention to the adequacy of technology for meeting user requirements for information; and
- to evaluate data management and dissemination aspects of EEZ activities and make recommendations for an optimum data management structure that encompasses all information gathered and the diverse interests of users.

The committee did not view its task as simply to present the results of surveys, but rather to combine the interests of various users with a broader perspective that takes into account the national interest in the ocean and its resources. Because the committee's advice was directed to the USGS and NOAA in relation to ongoing mapping and research activities, the focus of attention was on data related to the seabed including geology, mapping and bathymetry, and on nonliving resources. Consequently, living resources and biological information were not given equal attention with nonliving resources in the committee's analysis of priorities for information about the EEZ, although the committee recognizes that there would be major benefits associated with making information available about the living resources of the ocean.

STUDY METHOD

This report is based on three phases of investigation linked by common aims: first, an analysis of responses to a questionnaire sent to state coastal and ocean management agencies in the coastal states and territories asking them to prioritize their information needs in relation to present and planned uses of their offshore areas (NRC, 1990); second, a workshop to which representatives of existing and potential offshore industries were invited, along with the analysis of responses to a questionnaire to the participants (NRC, 1991a); and third, a survey of members of the ocean research community. Information was sought from each community on the following subjects:

- determination of type and priority of seabed data needs in relation to planned activities
- assessment of existing technology and tools for gathering seabed data and future technology needs
- description of data and information management problems and needs

In the course of the investigations, another topic emerged as a central issue among the nonfederal user communities: the need for mechanisms for establishing a formal participatory role by these nonfederal communities in planning future activities in the EEZ.

This report is a synthesis of the findings from all stages of the investigation and includes specific conclusions and recommendations to promote and guide the national effort to acquire the data and information necessary to understand and manage the nation's ocean territory.

ACKNOWLEDGMENTS

The committee gratefully acknowledges the generous contribution of time and information by the liaison representatives to this study: Millington Lockwood of the National Oceanic and Atmospheric Administration, and Bonnie A. McGregor of the U.S. Geological Survey, Office of Energy and Marine Geology. The respondents to the four surveys and participants in the two workshops that formed the core of this study also provided invaluable information, and although they are too numerous to name here, their thoughtful answers and participation are much appreciated.

EXECUTIVE SUMMARY

The vast seabed domain awaits new information and techniques that will allow its use for a variety of purposes. In 1983, the United States extended its "sovereign rights and jurisdiction" over the natural resources of the ocean out to 200 nautical miles through a Presidential proclamation of a U.S. Exclusive Economic Zone (EEZ). With this proclamation came new opportunities as well as challenges for exploring, understanding, developing, and preserving a geographically vast and diverse frontier region.

The nation's interest in conservation and wise management of its ocean territory requires a sustained public investment in information gathering and management activities in this region. Since 1983, the U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA) have carried out a program to characterize the seafloor of the U.S. EEZ. In 1984, the two agencies signed a Memorandum of Understanding to coordinate their EEZ activities, establishing the Joint Office for Mapping and Research (JOMAR) to carry out this coordination and provide leadership for the design and implementation of a national program.

In 1988, the Director of the USGS and the Administrator of NOAA requested that the National Research Council establish a committee to advise them on the needs and priorities of nonfederal users for seabed information from a federal mapping and research program, to assess the technical aspects of the national program with special attention to the adequacy of technology for meeting user information requirements, and to evaluate data management and dissemination aspects of EEZ activities. Because the committee's advice was directed to the USGS and NOAA in relation to ongoing mapping and research activities, the focus of this investigation is on the seabed of the EEZ and on nonliving resources.

Through a series of questionnaires and workshops, the Committee on EEZ Information Needs sought information on user needs from the major nonfederal communities with an interest in the EEZ: the coastal states and territories, the offshore industries, and the ocean research community. The following findings, conclusions, and recommendations emerged from the study and represent a synthesis of the findings from all stages of the investigation.

SUMMARY OF FINDINGS

- The coordinated USGS/NOAA effort to obtain reconnaissance information about the EEZ seabed in water depths greater than 200 m has been highly successful. Deep waters around the 50 states have been imaged with sidescan sonar, and the production of maps, atlases, and electronic data disks is nearing completion for these regions. Plans are in place to complete the imaging of the seabed around the Pacific Islands by 1997. Availability of data from these activities has been communicated to potential users through biennial symposia and a regular newsletter.
- Surveying and mapping activities such as bathymetry, acoustic imaging, and reflection profiling are conducted by federal agencies (including the military), the states, academia, and various industries. There is little effort to coordinate such activities and organize and utilize complementary data sets.
- Competition and conflict exist in some cases between private and public sector data gathering and dissemination activities. Policies are needed that delineate the proper balance between the public need for information and the private sector's right to be free of unfair competition from publicly funded activities.

- Attempts to take advantage of existing data are often frustrated by a lack of knowledge of what data has been collected, where they are stored, and how they can be accessed. The lack of common formatting standards makes it difficult for users to access and use each others' data.
- Seafloor mapping technology has made rapid advances in the last few years and efficiencies have been greatly improved. However, there is considerable room for progress in developing technologies that can remotely or directly sample and identify attributes of sediments as needed for specific resource and site evaluations (e.g., lithology, ore mineral concentration, bed thickness, etc.).
- The greatest information needs of the users in the states, industry, and academia are for bathymetry, imagery, and seabed characterization. Most users are also interested in information about living resources, which is not presently included in the national EEZ research activities and was not within the scope of this investigation. The current USGS and NOAA EEZ programs are highly successful in providing seafloor imagery and bathymetric data (respectively) that are useful in a regional context. However, such information needs to be supplemented with additional data that can be used to provide a better assessment of resource potential or hazards, to develop a better scientific understanding of the geologic processes that formed or are ongoing on the continental margins, and to assure an improved assessment of environmental conditions.
- There is strong interest in the nearshore shallow water regions (<200 m) of the EEZ. Systematic exploration of these areas will require technological systems that are fundamentally different from those used by the USGS and NOAA in the initial phase of their EEZ activities: new ships, towed instruments, and remotely operated vehicles that can be equipped with multiple geophysical, geochemical, and geotechnical sensors.
- All groups indicated the need for digital database development and information management. The USGS and NOAA need to define their roles in establishing data gathering and data management standards, procedures, and guidelines for use by all organizations active in the EEZ. The databases of EEZ information should be easily accessible by a wide variety of users, yet the system should be flexible and capable of evolving to meet the changing needs of its clientele, as well as the opportunities afforded by new technological developments.
- Mechanisms are needed to involve the nonfederal users in a formal and ongoing process of providing direction, defining objectives, and setting priorities for federal EEZ activities.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

The committee's investigations indicate that the nation needs an effective and sustained effort to collect, manage and distribute information on the Exclusive Economic Zone in order to provide an adequate understanding of resources, hazards, and ecosystems that will serve as the basis for sound management decisions. Following are specific conclusions and recommendations that emerged from the synthesis of all phases of the investigations and the recommendations for actions to establish a more effective and efficient national program for gathering and disseminating data about the EEZ seabed and ensure that the activities that are undertaken are responsive to the needs of all users and potential users as well as support the exercise of wise stewardship over this region.

Creating a National Program

CONCLUSION:

- While current federal budgets and foreseeable market conditions do not warrant a large-scale national EEZ program, a modest and sustained national effort is needed (1) to provide the basic information necessary to the long-term national interest in development of resources and for the wise stewardship of our ocean regions, and (2) to ensure that existing data are accessible and widely disseminated as needed. The national effort to acquire, analyze, and disseminate seabed information to meet user needs merits dedicated assets and human resources as well as stable funding.

RECOMMENDATION:

- A permanent program should be established for long-term seabed mapping and research activities and efficient dissemination of existing and future data products. The permanent program envisioned can be established through Congressional legislation, by Executive Branch mandate, or through internal agency actions. The essential elements are: unified management and operational structure; a dedicated, defined, and stable budget; guaranteed assets (e.g., ship time, instruments) and personnel; and formal participation by nonfederal users in planning and priority setting. The federal program should encourage a strong and competitive private sector component in ocean technology development, data gathering, and data dissemination activities. The committee finds that federal authorizing legislation is the most effective route to accomplish these objectives.

Working Together

CONCLUSION:

- The expenditure of federal funds for mapping and research activities in the EEZ needs to become user driven in order to acquire the support needed to mount sustained and effective data acquisition activities and build an efficient data management and distribution system for national ocean information. Planning for future activities will benefit from structured and ongoing participation and oversight by all current and potential users, including states, industry, and academia through an ongoing formally established mechanism or process, such as a task force.

RECOMMENDATION:

- The U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA) should establish a formal program planning structure composed of representatives of nonfederal users of Exclusive Economic Zone information and data to plan scientific activities, design data management systems, and establish priorities for activities. This planning group should be linked to other federal agencies, both civilian and defense, that are conducting EEZ mapping, research, and data management activities.

Building an Information Management System

CONCLUSION:

- There is a need for a federally managed EEZ data and information management system that is aimed at providing access to data for a wide range of users--civilian and defense and public and private--rather than at simply archiving data.

RECOMMENDATION:

- Lead agencies for the seabed research and mapping program (the USGS and NOAA) should establish an access-oriented EEZ data and information management system that assures that existing and new information is brought into a unified system that is easily accessible to all users. Cooperative links should be formed with existing civilian and defense ocean data management, dissemination, and archiving projects.

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The committee's investigations have revealed that the nation needs an effective and sustained effort to collect, manage, and distribute information about the seabed of the Exclusive Economic Zone to meet requirements of a number of users of this information now and in the future. The coastal states and territories have indicated that this information is necessary to planning and managing wise conservation and appropriate development of their coastal areas. Offshore industries--such as the oil and gas and communication cable industries--are already venturing into the EEZ regions and depend on oceanographic, geologic, and geotechnical information for the identification of resources, project siting decisions, and construction of models for predicting the impacts of any development activity. The ocean research community uses data from federal EEZ mapping and research programs as the foundation for understanding basic ocean and seabed processes.

A stable, long-term national program for gathering information about seabed resources, hazards, and processes will require a partnership of data users and providers in order to target limited resources towards priority activities that will meet user needs and lead to the timely attainment of national goals for the ocean. Using the seabed to its full potential in a manner consistent with wise stewardship of the marine environment will involve investment of resources with a long lead time, but the benefits to the nation will be substantial.

1

THE EXCLUSIVE ECONOMIC ZONE

In 1983, the United States extended its "sovereign rights and jurisdiction" over the natural resources of the ocean out to 200 nautical miles (nm) through a Presidential proclamation of a U.S. Exclusive Economic Zone (EEZ). This proclamation brought to the nation's attention the enormous potential of the waters and seabed surrounding the United States. With these new opportunities came further challenges for exploring, understanding, developing, and preserving a geographically vast and diverse frontier region.

The United States (along with other coastal countries) is looking to the ocean for a wider variety of uses including for recreation and tourism and for critical resources. All present and projected uses give rise to concerns about environmental protection. Some one hundred nations have now proclaimed jurisdiction over the natural resources within their EEZ (i.e., out to a distance of 200 nm seaward of the coastal baseline). The U.S. EEZ is the largest in the world, covering 3.9 billion acres of submarine land--approximately 1.3 times the onshore U.S. territory (Figure 1).

The oceans provide an enormous opportunity for a new resource base for growth and development. A previous investigation by the National Research Council concluded that in the near future, the role of the oceans in providing energy and mineral resources and in transportation, communication, disposal of wastes, and as a source of food is likely to increase under the pressures created by economic and population growth (NRC, 1989). The seabed of the deep oceans, in particular, comprises a vast domain awaiting new information and techniques that will allow its development for a variety of purposes.

Present and possible future uses of the EEZ seabed are as varied as the region itself. In addition to the recovery of hydrocarbon and hard mineral resources, it is the site of extensive commercial fisheries, communication cables, and military activities. Potential uses include ocean energy resources, deep ocean water for agriculture and cooling, pharmaceutical research, archaeology, transport, and recreation, as well as consideration for disposal of various classes of waste and sediments.

The contribution of commercial (nongovernment) ocean-related economic activities to the national GNP has been estimated at 1.7 percent ($76 billion) of the total U.S. gross national product of $4.527 trillion in 1987 (G. Pontecorvo. 1989). This is the same order of magnitude as other major segments of the U.S. economy, such as all farms ($76 billion), all mining excluding offshore oil and gas ($74 billion), transportation other than shipping ($131 billion), and communications ($121 billion).

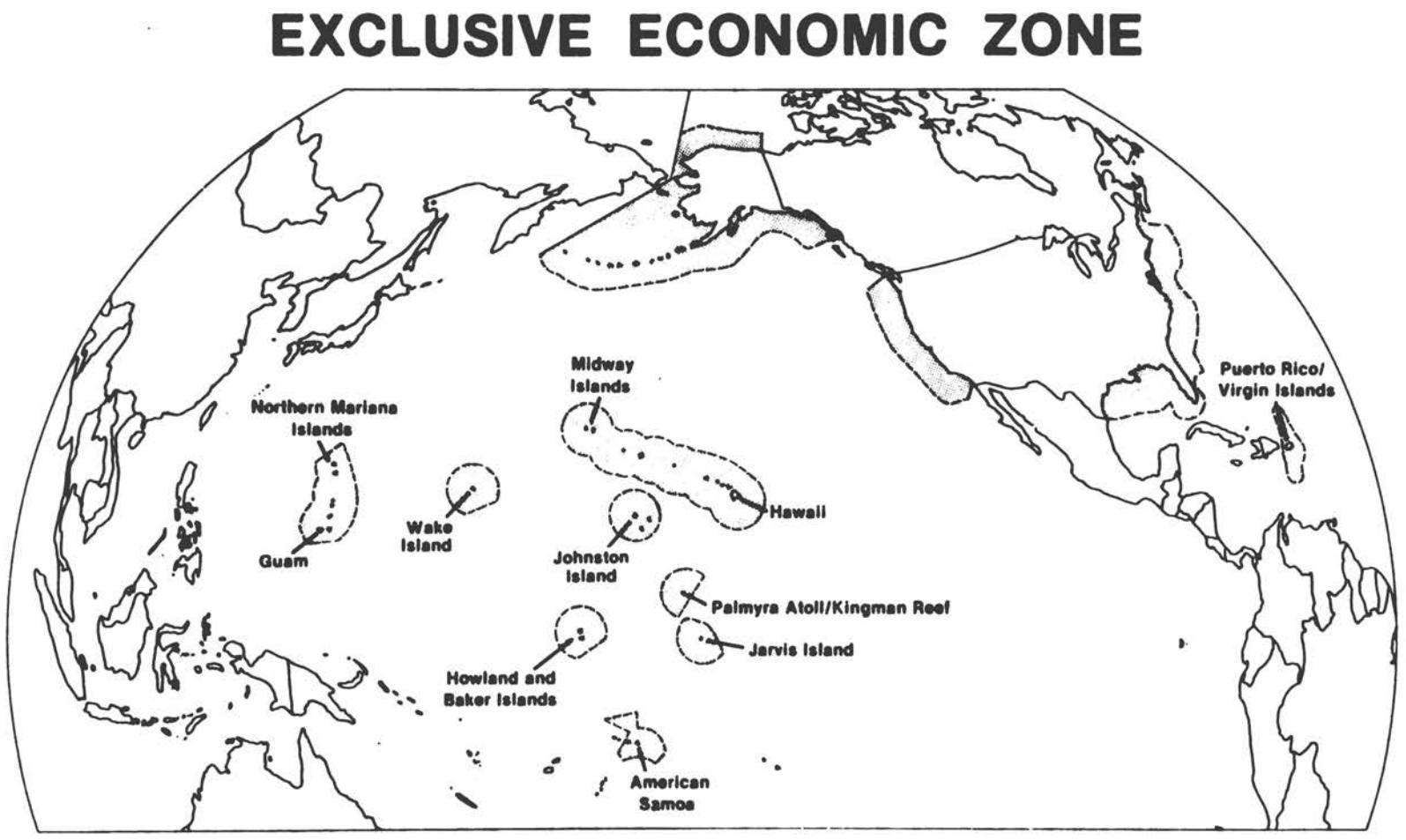

FIGURE 1 The Exclusive Economic Zone of the United States and its trust territories.

SOURCE: McGregor and Lockwood, 1985, p.2.

THE FEDERAL ROLE IN THE OCEANS

The role of the federal government in exploring and mapping new territories is well established in the United States. For example, after the purchase of the Louisiana Territory in 1803, President Jefferson launched the Lewis and Clark expedition to map and characterize the resources of this unknown territory. The U.S. Coast and Geodetic Survey has been mapping the coastal waters since 1807. The U.S. Geological Survey was established as a National Mapping Agency in 1879. Information is the necessary prerequisite for one of the essential functions of government--the design and implementation of regulatory jurisdiction over the nation's publicly owned resources. Wise regulation is based on sound technical knowledge. Development and utilization of the nation's Exclusive Economic Zone will rest on a foundation of government sponsored mapping and research activities including acquisition of basic scientific information on resources and environmental conditions; establishment of procedures for managing the resources of the area; and continued investment in basic science and engineering to enable development and applications by the private sector.

The nation's interest in sound conservation and development policies for marine regions and resources requires a sustained public investment in information gathering activities. Major oil companies have been moving their exploration activities into deeper waters in the Gulf of Mexico over the past decade, and recent discoveries of oil-bearing zones with major prospects in waters ranging from 2,900 to 3,100 feet in the Gulf of Mexico (Shirley, 1991) indicate that these expensive exploration activities are likely to offer an economic return. Although market demand for expansion of other forms of commercial utilization of the EEZ may be some years away, this postponement offers the advantage of time in which to gather the scientific information to characterize the resources, develop technology, and devise environmentally sound management procedures.

The development of a national program for mapping, resource exploration, use and management of the EEZ seabed has been the subject of numerous major studies since the Presidential EEZ proclamation in 1983. The studies include symposia sponsored by the USGS and NOAA on a biennial basis since 1983 (USGS/NOAA 1984, 1986, 1988, 1990, 1992), two reports by the National Advisory Committee on Oceans and Atmosphere (NACOA 1984, 1986), a report by the Office of Technology Assessment on Seabed Minerals (OTA, 1987) and a report by the predecessor committee to this study (NRC 1989). All the reports reached the consensus that a scientific and technological base of understanding for the responsible use of the EEZ and its resources is essential to the nation's long-term interests in the ocean and its resources. Further, the studies concluded that there should be a common, coordinated national effort to pursue these goals involving appropriate federal agencies, academic research institutions, industries, coastal states, and public interest groups concerned about the ocean environment.

NATIONAL EEZ MAPPING AND RESEARCH ACTIVITIES

The USGS/NOAA Joint Office of Mapping and Research

In 1983, the U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA) initiated a program to characterize the seafloor of the U.S. Exclusive Economic Zone. In 1984, NOAA and the USGS signed a Memorandum of Understanding to coordinate their EEZ activities, establishing the Joint Office for Mapping and Research (JOMAR) to carry out this coordination. The USGS/NOAA activities in the EEZ operate with the following focus at the present time (Lockwood and Hill, 1989):

- The geographical area encompassed is from the coastline to 200 nautical miles -- the Territorial Sea and the waters generally under state jurisdiction are included in these activities.
- The program is generally limited to technology and assets available through ongoing federal programs.
- The focus of activities is on large-scale imagery to determine the shape and texture of the seafloor, the profiling of its sediment cover to understand the processes that form the seafloor, and investigations of the mechanisms that transport material to seafloor sediment repositories.

In addition to coordinating USGS and NOAA mapping and research activities, JOMAR's objective is to provide leadership for the design and implementation of a national program to characterize the EEZ and its nonliving resources. In order to assess the data and information requirements of present and potential users of the EEZ, JOMAR has formed a Federal Users' Coordination Committee, conducted a series of biennial symposia to provide a forum for academic, industry, and state viewpoints to be expressed, and conducted a Federal Agency Seafloor Information Survey.* The study that culminated in this report was requested to assist JOMAR in identifying nonfederal users' needs for information from the joint activities.

NOAA Bathymetry

Bathymetric maps at 1:1,000,000-1:250,000 scales are available for most of the waters of the U.S. EEZ. These maps, which are based upon classical hydrographic survey or other trackline data, vary in quality and resolution depending on the age of surveys, type of navigation used, sounding system, and distance between survey lines. This latter factor is the primary consideration in determining the resolution of bathymetry maps (and, thus, the scale at which a map can be produced) in offshore waters greater than 100-150 meters. A limited amount of the nearshore areas have been mapped at 1:100,000 or 1:24,000 as part of a long-standing cooperative mapping project with the USGS or Minerals Management Service to support oil and gas development in the outer continental shelf (OCS) and coastal zone management. Many of these maps are based upon high quality NOAA hydrographic surveys that were collected to International Hydrographic Office (IHO) standards as part of NOAA's nautical charting responsibility. Much of the data used to construct these maps is available in digital form through the NOAA National Geophysical Data Center located in Boulder, Colorado.

Since 1984, NOAA, in cooperation with the USGS, has been conducting multibeam bathymetric surveying activities in the EEZ. The objectives of these surveys are to complete the mapping of the U.S. EEZ at approximately the scale and density of those maps currently available for the nearshore (continental shelf) waters and to produce data sets to complement the USGS GLORIA project (see discussion on p. 11). In the eight years of multibeam survey operations, NOAA ships have completed approximately 110,000 square nautical miles of the EEZ using multibeam sonar mapping systems. These systems are operated in water depths greater than 150 meters to produce bathymetric maps and digital data sets. The detailed contours of these maps provide information on the size, shape, and location of underwater features previously unknown. Figures 2A and 2B are examples of shaded relief imagery of two of the largest areas of the U.S. EEZ surveyed to date.

*For information about these activities, contact Millington Lockwood, Deputy, USGS/NOAA Joint Office for Mapping and Research, 915 National Center, Reston, Virginia 22092.

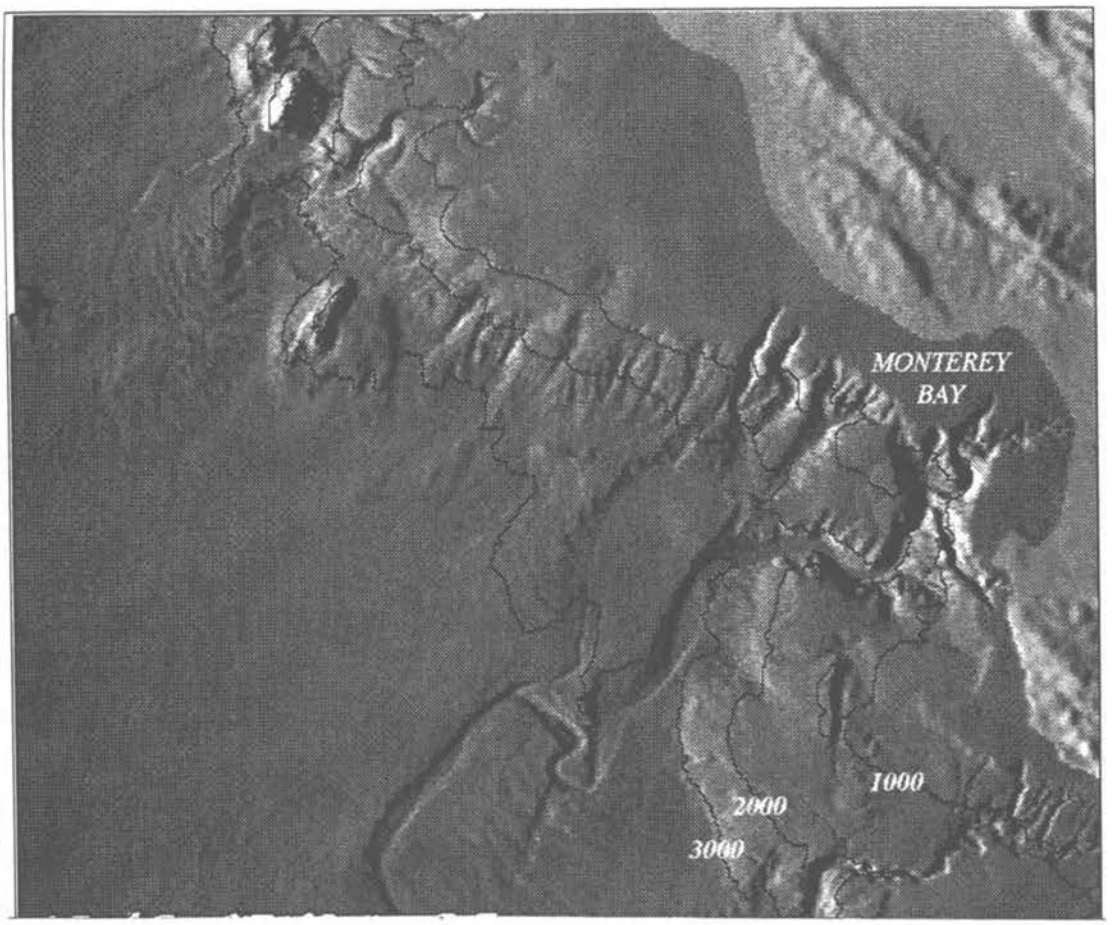

FIGURE 2A Shaded relief imagery of the ocean floor offshore Monterey, California. The light gray terrain in the NE corner represents land and is displayed using elevation data from topographic databases created by USGS. Total area is approximately 40,000 km^2, and the illumination is from the west. Contours (lines) are in meters. (Pratson and Ryan, Lamont-Doherty Geological Observatory.)

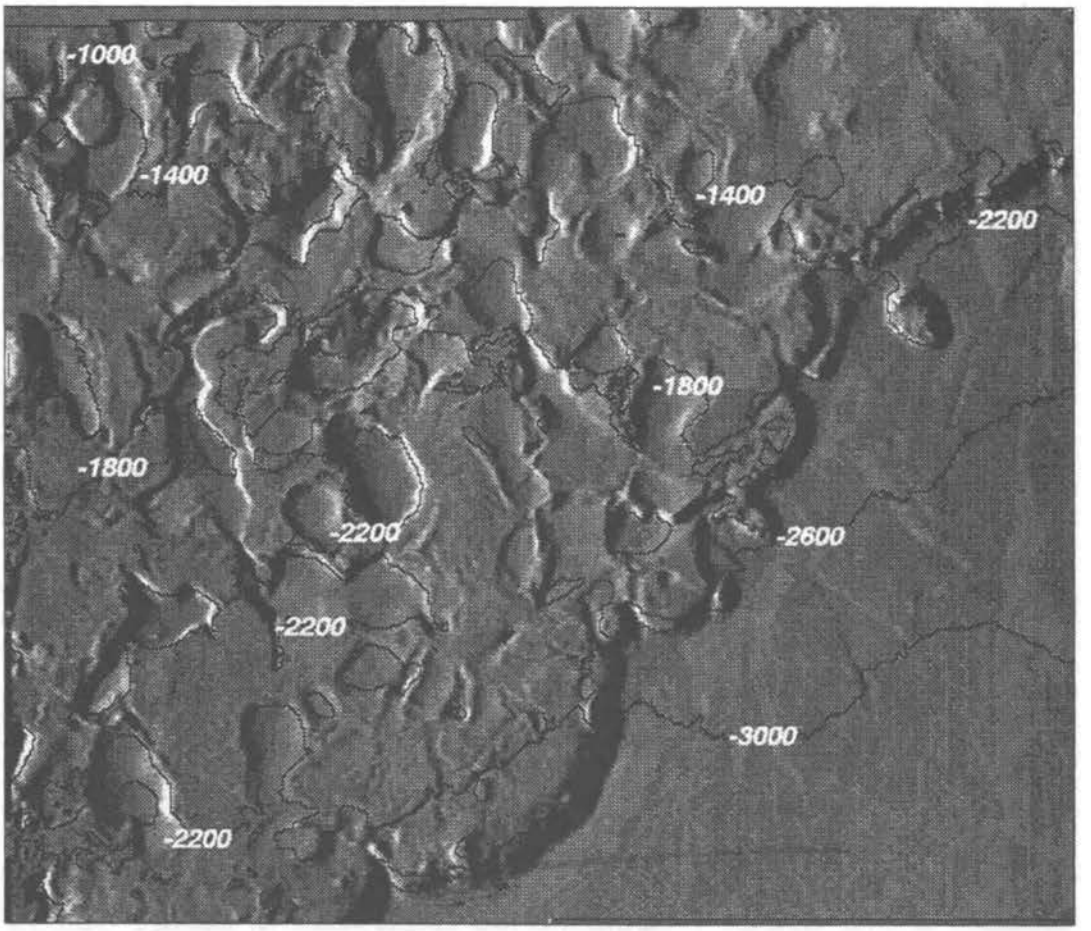

FIGURE 2B Shaded relief imagery of the ocean floor on the northern continental margin of the Gulf of Mexico offshore Louisiana and Texas. Images are derived from NOAA gridded multibeam bathymetric data. The NW region includes the continental slope with its numerous small basins formed by recent movements of underlying salt. The smooth surface in the SE is the Mississippi fan area that is approximately 30,000 km^2, and the illumination is from the west. Contours (lines) are in meters. (L. Pratson, Lamont-Doherty Geological Observatory.)

Fifty-six 1:100,000-scale bathymetric maps with a 20-meter contour interval, mostly covering one-half degree of latitude by one degree of longitude, are now available. Of these, there are six maps off Hawaii, four maps off Alaska, twelve maps off Oregon, and thirteen maps off California. Digital data sets are also available for each printed map. Surveys are not currently scheduled in the Pacific during 1993 due to other higher priorities for NOAA vessels. However, bathymetric mapping will continue in the Gulf of Mexico and off the coast of North Carolina in 1993 (Mills, 1992; M. Lockwood/NOAA, personal communication, July 1992).

USGS GLORIA Surveys

The USGS undertook a program beginning in 1984 to map the EEZ at a reconnaissance scale to provide a broad overview of regional geology, geologic processes, large-scale variations in seafloor morphology, rock or sediment type, and features resulting from long-term evolution of continental and island margins. Using a broad swath side-scan sonar system developed in the United Kingdom (GLORIA-Geologic Long Range Inclined Asdic[1]), rapid, large-area, regional coverage of large-scale features is possible. The GLORIA system is particularly useful for reconnaissance surveys of frontier regions, revealing features and characteristics of the seafloor previously unknown (Rowland, Goud, and McGregor, 1983). Since initiating their GLORIA surveys in 1984, the USGS has finished mapping the 50 state portion of the EEZ. Current plans are to finish the island territories of the central and western Pacific in a 3-year effort projected to begin in 1994.

Data from these surveys are published in atlases, with digital data also available on CD-ROM (Table 1). Atlases for the following areas have been published: West Coast of the Conterminous United States, Gulf of Mexico, Puerto Rico, East Coast, and the Bering Sea. The first of three atlases for Hawaii and the atlas for the area south of the Aleutian Islands are expected to be available by 1994 (B. McGregor, USGS, personal communication, 1992).

The USGS has also targeted specific regions for detailed studies (e.g., the Farallon Islands National Marine Sanctuary, the Monterey fan, and the Mississippi fan), where the GLORIA imagery will be combined with bathymetry and other data (such as subbottom profiles, sediment samples, and bottom photography) to provide geologic, physical, topographic, and structural interpretations.

The USGS plans to add an interferometric[2] bathymetry capability to the GLORIA system for the next phase of mapping activities in the Pacific island territories, where current data are sparse. This will enable mapping using topographic information simultaneously with the GLORIA imagery. The registered data sets will aid in the processing of the sidescan data and permit visualization techniques to be applied to the seafloor (Frederick, 1991; Lesnikowski, 1992, Lockwood and Hill, 1989).

Use of USGS/NOAA Data Products

Bathymetric and image maps and digital data are used for a wide range of purposes including safe navigation, better management of living and nonliving resources, modeling geological hazards affecting coastal regions and offshore construction projects, routing of cables and pipelines, and discovering or defining unique or previously unknown marine environments for designation as marine sanctuaries or protected areas (Mills, 1992).

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[1]Asdic is a type of sonar.

[2]Acoustic signals received at two spatially separated sonar arrays can be summed together to create an interference pattern that depicts the phase relationship of the signals being received at each array. Phase measuring interferometers used in swath systems measure small phase differences to calculate the offset angles necessary for converting slant-range distances to depths.

TABLE 1 GLORIA Data Processing and Publication

EEZ Region	Data Collection	Data Processing	Atlas Production	Atlas Published	Atlas Series	CD-ROM Disk
Conterminous West Coast	1984 Complete	Complete	Complete	March 1986	I-1792	1991 (North) Released 1993 (South)***
Gulf of Mexico	1985 Complete	Complete	Complete	October 1987	I-1864-A	1987 Released**
Puerto Rico/ Virgin Islands	1986 Complete	Complete	Complete	October 1987	I-1864-B	1993***
Bering Sea	1986-1987 Complete	Complete	Complete	April 1991	I-2053	1992
East Coast	1987 Complete	Complete	Complete	September 1991	I-2054	1989 Released**
Hawaii I (Hawaii to Kauai)	1986-1988 Complete	Complete	In Progress	1994***		1994***
South of Aleutians	1987-1988 Complete	In Progress	In Progress	1994***		1994***
Gulf of Alaska	1988-1989 Complete	In Progress		1995***		1995***
Johnston Island	1991 Complete			1996***		1996***
Hawaii II	1988-1990 Complete	In Progress		1995***		1995***
Hawaii III	1988-1991 Complete			1996***		1996***
Guam/Northern Mariana Islands	1994-1996*					
Wake/Howland Islands	1996*					
Samoa/Jarvis Islands	1997*					

* Planned
** Released in 1993
*** Projected Completion

The GLORIA maps and digital data have been used as a basis for site-specific investigations related to fisheries management and protection and characterization of marine sanctuaries. They have also been used to determine areas where dredged material can be safely dumped, identify submerged hazards to transportation, and communication cables, and to ascertain the distribution of energy and mineral resources (Frederick, 1991). Specific examples of use of this data include the following:

- The GLORIA data are currently being used to troubleshoot communication cable failures, to establish potential re-routing of existing cables, and to determine new routes for future cable installations.
- Image data from the seafloor seaward of San Francisco Bay are being merged with subbottom information, sediment samples, and bottom photographs in a cooperative effort among several state and federal agencies. The information is being used by NOAA in designing a long-term regime for the Gulf of the Farallones Marine Sanctuary. The Environmental Protection Agency (EPA) is using the information to characterize and evaluate the risks at the site where low level radioactive wastes were disposed of in the 1950s. The Navy, Corps of Engineers, and EPA are using the data base of information to identify a suitable site for disposal of dredged materials from the San Francisco Bay port.
- An interdisciplinary study with NOAA's National Marine Fisheries Service is using image data, sediment samples, bottom photographs, and circulation information to document direct interactions between physical environmental factors and the abundance and distribution of fishery species.
- Image data from the Monterey fan and the Mississippi fan is being incorporated into exploration models to more effectively predict the distribution of oil and gas in ancient fan environments.

2

SEABED INFORMATION NEEDS

STUDY APPROACH

This report is based on three phases of investigation linked by common aims: first, an analysis of responses to a questionnaire sent to coastal and ocean management agencies in the coastal states and territories asking them to prioritize their information needs in relation to present and planned uses of their offshore areas (NRC, 1990), [See Appendix D]; second, findings from a workshop in which representatives of existing and potential offshore industries participated, along with the analysis of responses to a questionnaire to the participants (NRC, 1991a), [See Appendix E]; and third, analysis of responses to a survey of members of the ocean research community [See Appendix F]. Information was sought from each community on the following subjects:

- determination of type and priority of seabed data needs in relation to planned activities,
- assessment of existing technology and tools for gathering seabed data and future technology needs,
- description of data and information management problems and needs.

Early on in the study, it became apparent that data management problems and needs were a topic of major concern among users of seabed information. A workshop focused specifically on data management issues was led by the committee at the 1991 USGS/NOAA EEZ Symposium held in Portland, Oregon [See Appendix G].

Comments from respondents to the questionnaires in the state offices, private sector, and the research community and from discussions at the workshops pointed to the need for a formal mechanism to assure that federal EEZ activities address user needs. Therefore, the committee considered these issues throughout its investigations and included in subsequent questionnaires and workshops opportunities for respondents to express their views about improving the structure of the federal program.

FINDINGS

The findings presented here are based primarily on the results of the questionnaires to members of the three communities polled (coastal states and territories, offshore industries, and ocean research scientists) and to participants in the data management workshop held at the 1991 USGS/NOAA EEZ Symposium in Portland, Oregon, and on the content of the discussions at the two committee workshops [Workshop on Industry Needs, Boulder, Colorado, April 8-10, 1991; Data Management Issues Workshop, EEZ Symposium, Portland, Oregon, November 5-7, 1992].

In all cases, the structure of the questionnaires allowed incomplete, subjective, and impressionistic responses and, therefore, the responses are not susceptible to rigorous statistical analysis. Nor were the workshops alone sufficiently complete or sufficiently representative of the diverse communities with interests in offshore activities to be statistically valid. Further, a limited sample of the ocean industry and research communities was polled for this investigation.

With regard to the populations surveyed, the following considerations apply. All the coastal states and most of the territories provided responses (see NRC, 1990 for a list of state and territory respondents). The Workshop on Industry Needs was well represented by what is best described as "service" industries--companies conducting geophysical surveys and private consultants to the oil industry and for environmental assessments. The oil exploration and production industry was underrepresented at the workshop (see NRC, 1991a for a list of participants in the Industry Needs Workshop). The response to the questionnaire to the ocean research community was low (approximately 30 individuals responding out of 150 queried). Over half the participants in the data management workshop were federal employees (25 out of 44). When there was a perceived imbalance in representation, the committee sought to fill the gap either with its own expertise or from the expertise of other qualified colleagues. Additional information was provided by many respondents in cover letters, presentations, and other interchanges with committee members over the course of the study.

Despite the limitations of the investigation, results of the polls and discussions by the workshop participants indicate clear trends and provide useful insight into the relative importance of uses and information needs.

Data Types and User Requirements

The EEZ seabed is the focus of a highly diverse, broad range of scientific and engineering activities. The data needed to support these activities are similarly wide ranging. For example, regional seabed sediments may be studied as a means for fundamental understanding of geologic processes, whereas site-specific engineering properties of these sediments may be required as basic design input for offshore platform foundations. The types of seabed data typically collected from federal activities include data acquired by surveying and mapping techniques and those acquired by direct testing and or sampling of the seabed. Surveying and mapping techniques can be further categorized as bathymetry, imagery, seismic reflection profiling, and geophysical measurements. These data types along with seafloor sampling are described in detail in Table 2.

In some cases where needs are highly specific, data collection may involve only one of the above general data types. Quite frequently, however, two or more of these data types are acquired and utilized in a complementary manner. For example, direct sampling may be used to establish ground truth for seismic reflection profiling. Once surveying data are acquired, they are processed to produce seafloor maps, acoustic profiles, and other products. Samples are usually subjected to detailed examination including laboratory testing. These data are then interpreted to determine information about the seabed. Ultimately these results are used for scientific or engineering purposes including such end uses as geomorphology studies, production of bathymetric charts, hazardous waste tracking, and foundation design for offshore facilities.

The EEZ seabed represents a diverse and complex frontier environment where the processes that influence the interface between the ocean water column and seabed are dynamic and complex. As more activities are planned on the EEZ seabed, industry users, researchers, and government entities will need to collect and interpret many types of data. Consideration must be given to the impact of the seabed environment on the planned activity and vice versa. Since the users of EEZ data have varying interests, their requirements for data also vary. On the other hand there is sometimes overlap in data gathering

TABLE 2 Types of Seafloor Data and Technologies

Bathymetry:	**The measure of ocean floor relief and water depth.** Bathymetry is obtained by sonars mounted on a ship's hull or towed in a vehicle behind and below the ship or installed in remotely operated vehicles. Modern bathymetric systems are multibeam and/or interferometric; they generate information across a swath whose width increases and whose spatial resolution decreases with increasing water depth. Because of the systematic coverage of data obtained from modern systems, the resulting topographic maps portray the shape and depth of seafloor features with much greater fidelity than conventional maps.
Acoustic Imagery:	**The measure of the strength of back-scattered sound reflectivity to obtain a view of the seabed.** Side-looking (or side-scan) sonars (most commonly towed behind ships) generate acoustic images of swaths of the seafloor. From this type of information, inferences can be made about bottom roughness and substrate type (e.g., hard, soft, coarse, fine, rough, smooth). Geologic bedforms are portrayed which in turn give information about the physical and biological processes that form and modify the shape and texture of the seabed. Sonars towed near the seabed show the most detail, whereas sonars towed near the sea surface can provide the largest areal coverage, with a trade-off of resolution. Technology exists to wrap the surface of a three dimensional terrain model (made from bathymetry) with the back-scatter reflectivity (from side-looking sonar imagery) to obtain a more complete view of the submerged seascape than offered by any single data type.
Optical Imagery:	**The direct imaging of the seafloor with film and/or video cameras.** Optical imagery is generally obtained from towed sleds, remotely-operated vehicles, manned submersibles, or autonomous robots. Technology exists for digital data acquisition, direct telemetry to shore labs, and automatic processing to extract fixtures and measure three-dimensional relief and resolutions to a few millimeters.
Seismic Reflection Profiling:	**The measure of the acoustic properties and geometry of the subsurface beneath the seafloor.** Reflection profiling systems are generally high resolution to probe the upper few hundreds to tens of meters of the seabed in great detail or deep-penetration to probe the entire sediment cover and underlying basement rocks to depths of more than 20 km. From the geometry of the layers, inferences can be made concerning the type and age of the subsurface formations. From the acoustic properties, it is possible to calculate bulk density and detect horizons containing oil, gas, water, magma, etc. Reflection profiles reveal the presence of internal deformation (e.g., faulting, folding, intrusion, and collapse from dissolution). Modern technology offers a three-dimensional look in the subsurface and the ability to map the interfaces between layers.
Geophysical Measurements:	**The indirect measure of internal properties of the substrate using specialized sensors mounted in ships, airplanes, and satellites or placed on or within the seabed.** Gravity and magnetism are natural fields of force whose local amplitude can be determined. Variations from idealized amplitude are anomalies that reveal the nature of geologic features (e.g., a trench or a seamount). Other geophysical measurements include electrical conductivity, electrical resistivity, permeability, porosity, shear strength, density, nuclear radiation, and chemical profiling. Some tools measure these properties from within boreholes, other tools by dragging sensors along or in proximity to the seabed.
Seafloor Sampling:	**The direct recovery of materials for laboratory analysis.** Certain properties of the seabed can best be determined by direct sampling. Current methods of recovery include dredging, grabbing or box coring for surface materials, piston coring and drilling for deeper materials. Drilling in deep water has reached penetration depths of several km. Direct seafloor sampling is used to confirm inferences (i.e., provide ground truth) made from surficial topography and imagery. Direct recovery is necessary for precise compositional analyses, age dating, and pore-water chemistry. The downside of direct sampling is that it consumes time (=$), disrupts the material, and gives only a point measurement. In nature there is a large variability or patchiness of substrate types, which is poorly or incompletely determined from any reasonable density of point measurements.
Insitu Substrate Testing:	**An indirect probing of the physical properties of the subsurface.** In situ measurements are made with sensors inserted into the seabed, dragged across the seabed, or lowered into boreholes. They generally generate a profile that shows the spatial variability of one or more parameters. Most common is the electrical logging of boreholes to measure electrical resistance of the formations. Resistance and conductivity allow the detection of fluids such as hydrocarbons and determine the nature of the pore volume space (e.g., its porosity and permeability). In situ techniques are necessary to obtain reliable knowledge of formation pressure, temperature, strength, fracture density, and the state of stress. Engineering properties are more reliably measured in situ with probes than from the laboratory investigation of returned samples.

needs and activities. For example, an industrial concern may need data for design of a particular facility, whereas a state might require similar data to perform its regulatory role. Almost all users indicate a need for base topographic and geologic maps of the seafloor. All measurements and observations need to be accurately located in relation to latitude, longitude, and depth.

Coastal States and Territories

The survey of the states and territories identified the following principal concerns: management of biological resources, mineral resources, environmental assessment (including emplacement and monitoring of waste), shoreline management, and regionally focused interest in oil and gas development activities. Information related to pipelines, cables, ocean energy development, and cultural and recreational activities (i.e., marine sanctuaries and recreation) were of less interest. Military uses were occasionally of regional importance. All respondents gave high priority to acquisition of seabed information for research (Figure 3).

Priority of data needs among the different groups varied both with type of use and with the stage of development. However, bathymetry, characterization of bottom sediments, and near surface profiling (upper 50 m) were the highest priority information desired, along with acoustic imagery. Bottom sensing, geophysical data (especially deep seismic profiles), optical imagery, in situ testing, and borehole logging were less important for the principal applications listed (Figure 4).

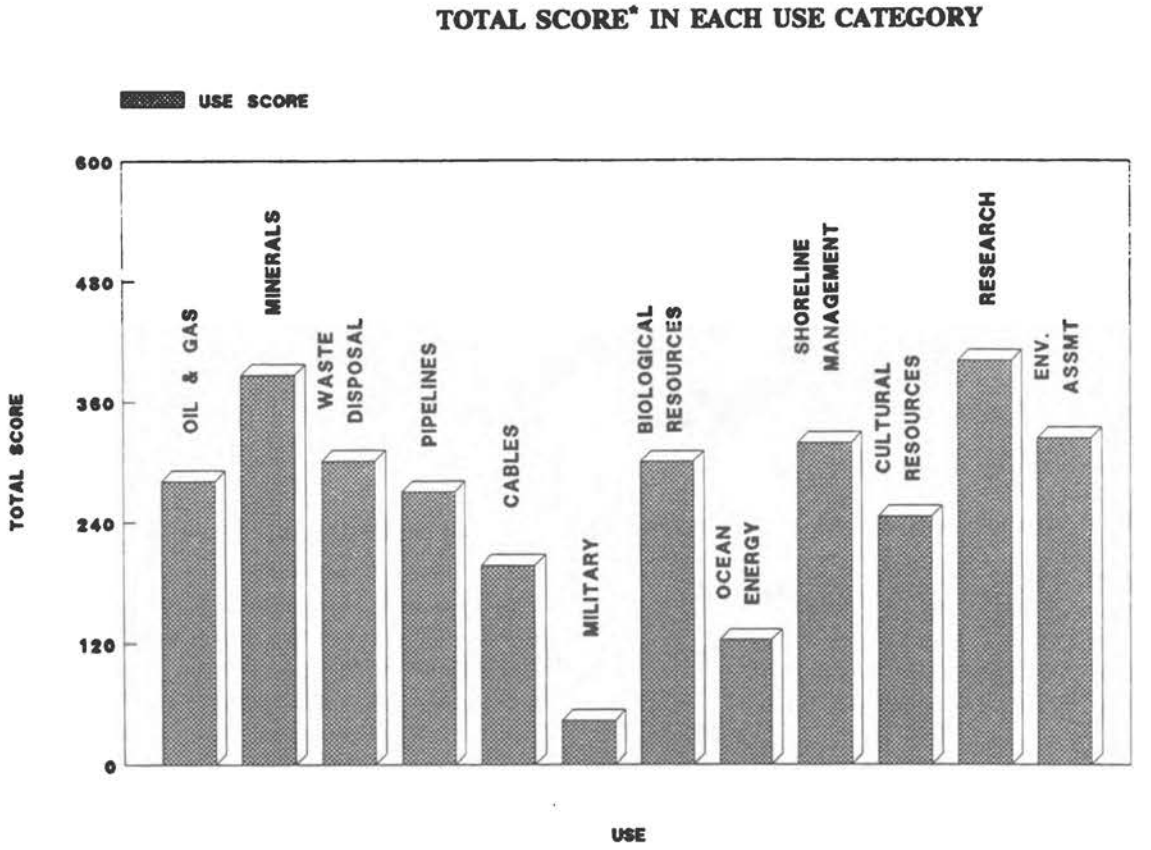
The geographic areas of interest focus on areas immediately offshore highly populated coastal cities and regions. The interest in nearshore areas corresponds with the states' jurisdictional role over activities in the Territorial Sea of the states, which extends three nautical miles offshore.

Offshore Industries

Private sector activity on the seabed of the EEZ primarily focuses on oil and gas development, communications cables, pipelines associated with the oil and gas activity, dredging (including disposal of dredged materials), and fisheries. Other potential uses are constrained by various factors, including unfavorable economic conditions (mining of marine materials) and legal prohibitions (ocean waste disposal), or await advances in scientific understanding (marine biotechnology) or design of improved technology and engineering systems (ocean energy, deepwater mining, and oil recovery). However, these uses are expected to expand in the future (NRC, 1989).

The survey of offshore industries confirmed an interest in a large number of data types as reflected in Figure 5. The data types ranked in order of priority are bathymetry, sediment characterization, acoustic imagery, seismic profiling, and lastly various subsets of geophysical data. The data types considered by industry to be essential were bathymetry, seafloor imagery, and remote seabed characterization accompanied by calibration sampling at scattered sites. The survey results were generally confirmed during the industry workshop. Industry responses also pointed out that, while considerable attention has been given to deep water (>200 m) in recent years, industry maintains a strong interest on the continental shelf (<200 m). The specific geographic interests of industry vary widely depending on the business interests involved.

A particular concern expressed by some industry participants is the provision by the public sector of information products on a subsidized basis that are for sale by private companies on a profit basis. It was generally agreed upon that it is inappropriate for publicly funded activities to directly compete with and undercut private sector activities. The federal government should encourage the development of commercial capabilities rather than impede them. Difficulties in designating the appropriate delineation

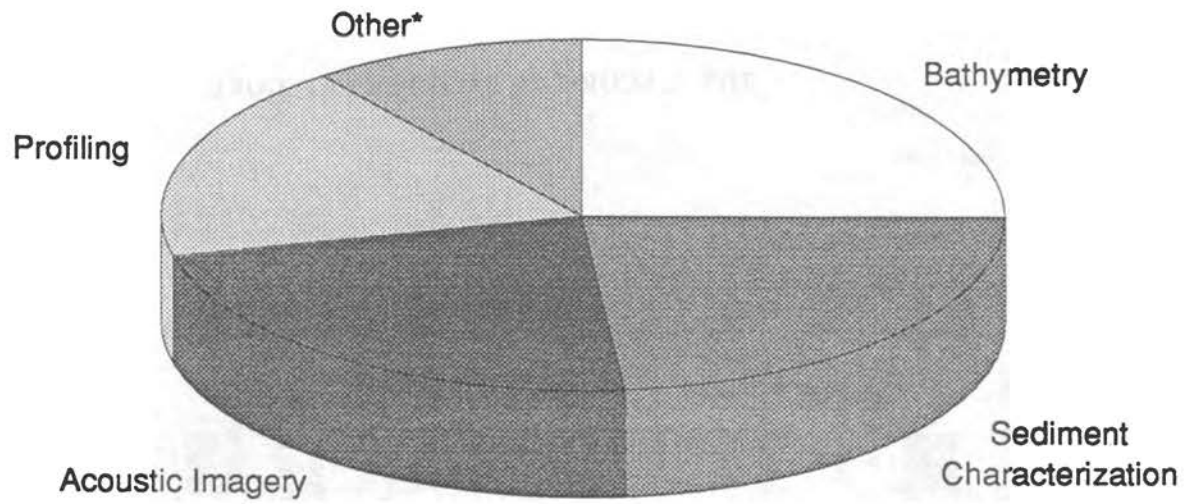


*score = number responding "essential" x 2, plus number responding "useful" (see questionnaire in Appendix D).

FIGURE 3 Weighted responses by coastal states and territories indicating information needs in relation to current and planned uses of offshore areas (See Appendix D).

SOURCE: National Research Council. 1990.

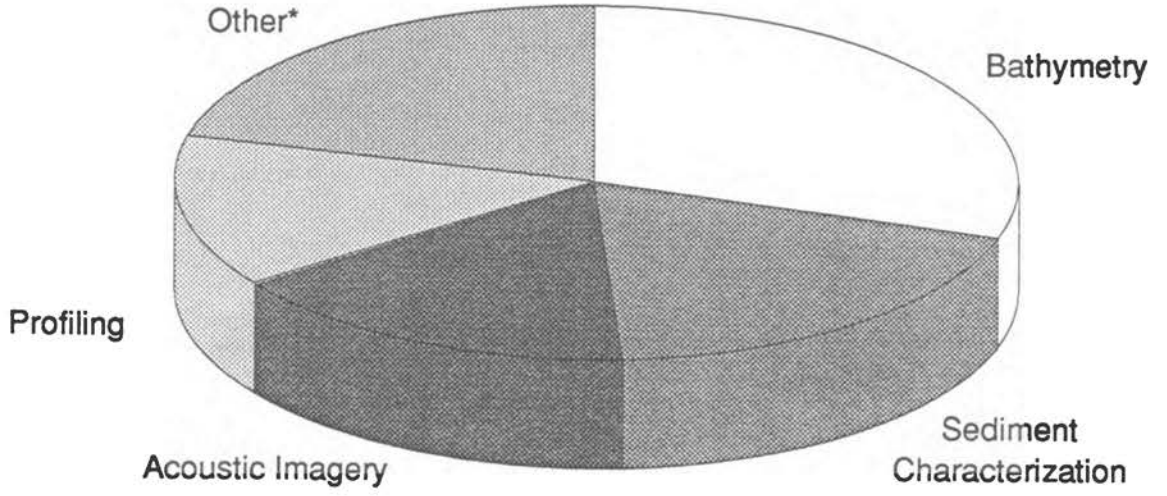
Coastal States and Territories



*Other: Bottom sensing, geophysics, optical imagery, in situ testing, borehole logging.

FIGURE 4 Responses by coastal states and territories indicating highest priority data types. (See Appendix D).
SOURCE: National Research Council. 1990.

Offshore Industries



*Other: Geophysics, borehole logging, in situ testing, optical imagery, bottom sensing.

FIGURE 5 Responses by industry indicating preferred data types (See Appendix E).
SOURCE: National Research Council. 1991a.

between publicly funded information gathering activities in the oceans and commercial activities is not always clear cut because much of the private data is acquired on a proprietary basis and, consequently, is not publicly available. In some cases, the public sector needs similar information as a basis for regulatory or security activities. These issues need to be addressed so that reasonable policies can be designed to achieve a proper balance between the public need for information and the private sector's right to be free of unfair competition from federal activities.

Research Community

The research community survey indicated support for the future program's focus in the following order of priority:

1. understanding of basic processes
2. systematic generation of maps and other products
3. long-range baseline studies or monitoring
4. interaction of the water column with the bottom.

The research community was consistent with other users in showing a strong preference for bathymetry data over all other data types. The interest in other data types, however, does not decline as rapidly as with the other user groups. The researchers expressed a much stronger interest in bottom sampling and only slightly less in acoustic imaging, followed by high resolution reflection profiling (Figure 6).

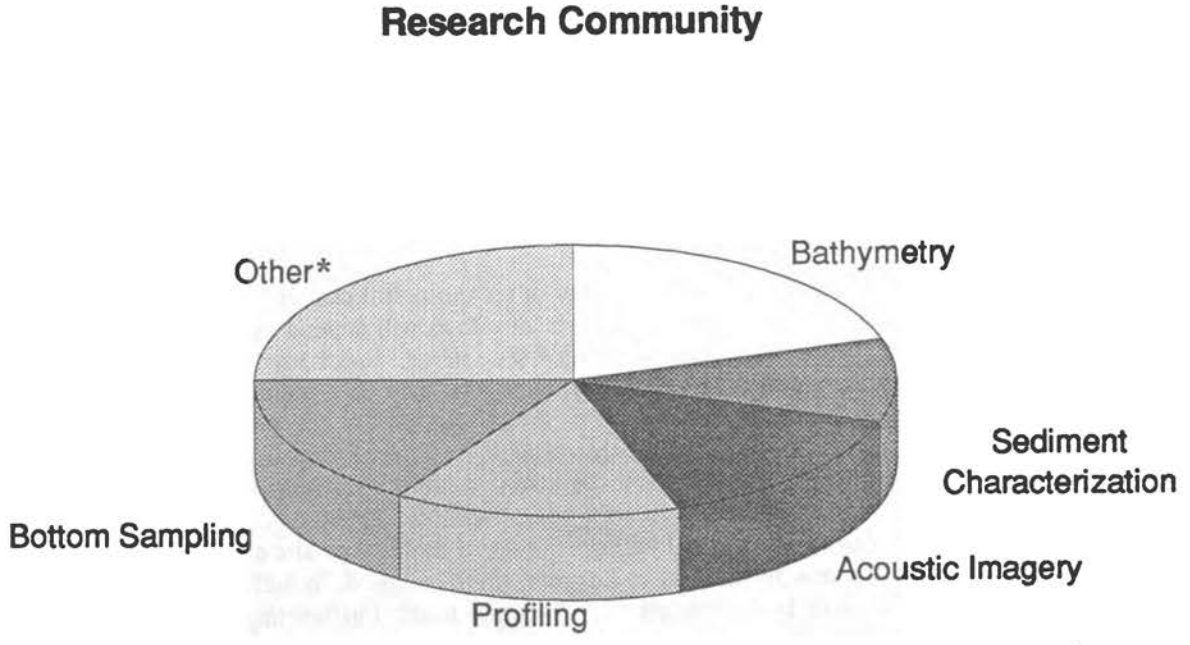
Technology Needs

Future utilization of the EEZ presents a variety of technological challenges or needs. Implementation of future offshore activities and development efforts will depend upon having the necessary tools to survey, map, probe, sample, and monitor the seabed. Specialized equipment will be required to obtain oceanographic, geologic, geotechnical, biological data on a regional scale, while other systems will be required for site-specific studies.

Many acoustic and optical tools are presently available to perform the surveying and mapping programs involving bathymetry, seafloor imagery (mostly acoustic, some photographic) subbottom profiling, and remote sensing. Each system has its own operational characteristics, particularly in terms of resolution and coverage rates, that make it most appropriate for a regional or site-specific program. However, there is still a need for new technology to improve survey methods and efficiency while balancing survey data quality with survey costs, both in terms of dollars and time. Further improvement in digital acquisition techniques and the ongoing development of real time data image enhancement are needed to improve survey and mapping effectiveness.

The current understanding of the seabed in the EEZ, is shaped by the technology that has been used to map and explore the ocean. The available technology directly affects, the pace, location, and cost of exploration, as well as the dissemination of the results (Wells, Mayer, and Clarke, 1991). The first phase of the USGS program to image the EEZ occurred exclusively in deep water. The system used for this project was the GLORIA II, which is optimal for imaging 45-60 km swaths in deep water but loses swath width efficiency in shallow water depths. NOAA's program to survey the U.S. EEZ also has generally focused on areas beyond the continental shelf with depths greater than 200 meters (Lockwood and Hill, 1989).

In spite of the federal program's previous emphases on projects in deep water, the coastal states and the industries appear to have strong interests in the shallow, nearshore areas of the EEZ and the continental shelf.[3] The returns from the ocean research community further substantiate the need to develop technology for remote methods of seafloor characterization and for conducting time series analyses from long-term in situ measurements. All three groups indicated that their highest priority information needs are for bathymetry and imagery data and for reflection profiles capable of illustrating small-scale spatial variability and illuminating the sub-bottom structure in homogenous materials (e.g., sands, gravels, and gas-bearing lithologies).



*Other: Optical imagery, water column, borehole logging and heat flow.

FIGURE 6 Responses by ocean research community indicating preferred data types (See questionnaire in Appendix F.)

[3] Deep water is generally defined as the region beyond the continental shelf (>200 meters depth).

Since the width of the survey swath for multibeam sonar systems is proportional to the water depth, the width becomes correspondingly smaller in shallow water. One effective solution is to open the aperture of the sonar. Figure 7 shows that this is being accomplished with some remarkable success. Another cost-effective improvement in survey efficiency comes with the simultaneous operation of several systems, one mounted on the survey ship and others on remotely-operated unmanned drones that transmit their data to the survey ship by radio link.

At high survey speed (which increases survey efficiency) it becomes difficult to maintain 100% coverage of the insonification due to the relatively long round-trip time of the sound extending to the lateral edges of wide swaths in comparison to the distance advanced between repetitive scanlines. There are new multichannel and multifrequency technologies on the horizon to assure total bottom coverage, essential for charting shoals and hazards to navigation. The systematic exploration of the shallow-water regions requires new technological approaches and the acquisition of a new suite of instruments and assets.

Detailed knowledge of seabed sediment characteristics will require measurements to be obtained by sampling, in situ testing, and experimental testing. This information is necessary to provide ground truth information for geophysical surveys performed as part of the mapping programs as well as to provide engineering design information for any planned facilities or developments. Although the current technology is adequate to conduct direct sampling of the seabed, the current techniques are time consuming and inefficient in deep water. They are also poorly designed for obtaining samples with geologic regions requiring numerous samples because of the great spatial variability of features, sediments, and processes.

At the industry workshop, many participants agreed that further development of new and improved acoustic and optical tools and equipment used for direct sampling and in situ testing of the seabed sediments and its natural resources are needed. It was concluded that a number of economic and technological benefits would accrue to the nation from partnerships between the public and private sectors for the capitalization of these new technologies. The following general needs were identified:

- accurate, simple, and inexpensive subsea navigation systems that could be deployed beneath the sea surface;
- small unmanned vessels equipped with multiple geophysical, geochemical, and geotechnical sensors that could be deployed, controlled, and monitored in groups over large areas from a single command ship for maximum and timely reconnaissance data-gathering efficiency;
- new high density power sources for remote technologies;
- seafloor sampling tools that could be deployed rapidly, be remotely operated from the support vessel, have short turn-around times, give maximum representative sample recovery, and work in both unconsolidated and hard rock substrata to penetration depths exceeding ten meters.
- for improved shallow water capability, swath bathymetric and imaging systems capable of providing lateral coverage of several times the water depth, possibly encompassing multispectral sensors.

Data and Information Management

The one need common to all the users surveyed is ready access to the information about the seabed. Improvements in technology and increases in effort have resulted in an increasing rate of data collection, with the total volume of EEZ data growing rapidly. As a result, many individual data collectors have had to define their own ad hoc data systems in order to deal with the large volume of information that is accumulating.

This issue emerged in written comments attached to the questionnaire sent to coastal management offices in the states and territories (NRC, 1990), and in discussions at the workshop on offshore industry needs (NRC, 1991a). Responses by the ocean research community to a question regarding the comparative importance of the allocation of resources to data management vs. data collection in the national program revealed a preponderance of the view that at least 50 per cent of program resources should go for data management. The widespread concern about this issue led the committee to organize a half-day workshop on the topic of data management in conjunction with the USGS/NOAA 1991 EEZ Symposium. A detailed discussion of this workshop is found in Appendix G. Following is a summary of the major points learned through this workshop and the questionnaires to the other user communities.

Users resoundingly endorsed the need for a government role in establishing, adopting, and publishing standards for data collection procedures, formats, and quality assurance based upon data type and intended use. User input to the establishment of such procedures and integration was viewed as an important part of defining database products. Access to EEZ data was a major concern, with a strong expression of the need for rapid, "user friendly" processes established by a government "keeper" of the master database of databases with clear delineation of access points. Present federal ocean and geophysical databases are viewed by these users as *archives* rather than as *interactive* sources of information. They are difficult to access, lacking categories of data targeted specifically for EEZ applications, and are made available at a rate that is not rapid enough for "real time" use. This analysis echoes the findings of a recent NRC study on data management needs in the area of research on global change (1991b).

Guiding principles for the evolutionary development of a seabed information system include the following:

- Involve the end-user community at the outset and throughout all subsequent activities, since the data will be acquired, transmitted, and processed for their use as well as the government.
- Provide a representative group of active users with oversight and review responsibilities, since the most successful examples of data base management involve user oversight.
- Establish and enforce adherence to agreed upon formats, standards and guidelines at all levels beginning with data acquisition, as early as possible and update them as often as needed.

All of the communities surveyed in this investigation supported a government role in establishing, adopting, and publishing standards for data collection procedures, data formats, and data quality assurance. Access to EEZ data was a major concern expressed through the workshops and questionnaires, with suggestions that rapid, user friendly access to data be established (dial 1/800-EEZ-DATA) for easy inventory of data location and characteristics through a single point of contact in the federal government. This implies a federal keeper of the master database of databases rather than the present role of government as maintaining an archive of data (i.e., providing active access to rather than passive storage of information).

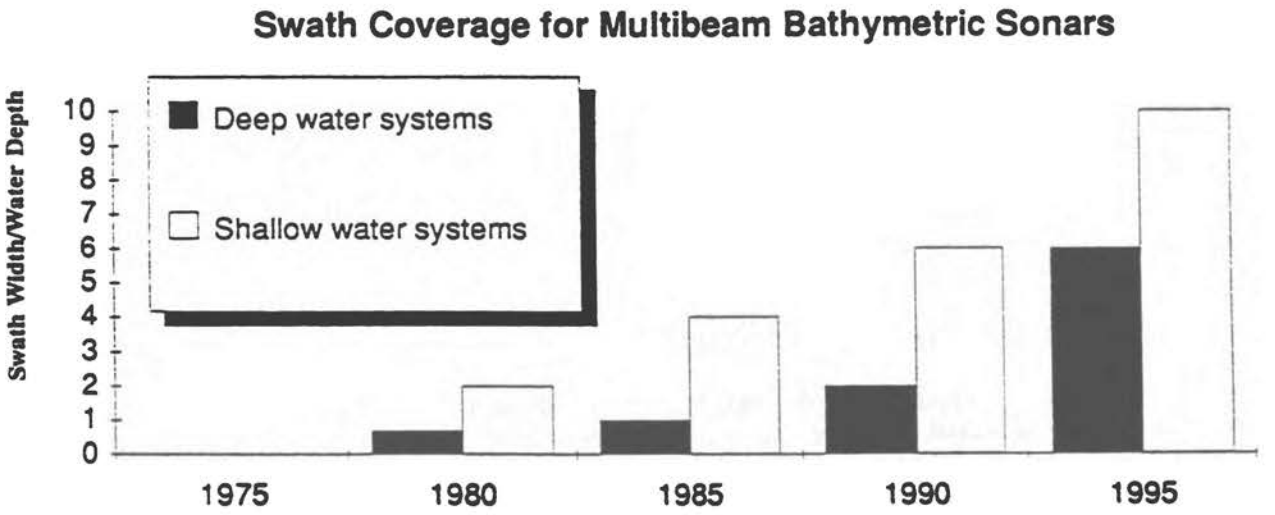


FIGURE 7 Swath coverage of multibeam bathymetric systems commercially available 1975-1995* The width of the swath covered by multibeam bathymetric sonars increases proportionally with water depth. Shown here on the vertical axis is the ratio of the swath width to the water depth. Technical improvements have led to a steady increase in this ratio, giving newer systems the advantage of being able to survey more area of the seafloor per day than older systems. The capability of having a broad swath width is particularly important in shallow water.

*projected

Program Implementation

The 1989 NRC report, *Our Seabed Frontier: Challenges and Choices*, recommended as a first action for devising "a coherent plan for developing [the nation's] ocean territory" that "Congress should [create] a formal joint planning and coordination process that includes a lead agency mandated to develop a national EEZ plan, an external commission composed of representatives of industry, academia, and public interest groups, and an internal interagency committee" (NRC, 1989).

Throughout the investigation, both in questionnaires and workshops, participants were asked to consider what kind of structure was needed to implement and plan future EEZ activities. The participants in the surveys and workshops were in a broad consensus that a national program should be guided by a planning structure that includes representation by all present and potential user communities (i.e., states, industry, ocean researchers, federal agencies). Such a process was viewed as a means for ensuring that user data needs are met in the future and that coordination of limited assets is achieved through cooperative endeavors. These views were expressed in extensive written addenda to the responses from the state agencies and the ocean research community and in discussions at the offshore industry workshop and the data management workshop.

SUMMARY OF FINDINGS

- The coordinated USGS/NOAA effort to obtain reconnaissance information about the EEZ seabed in water depths greater than 200 m has been highly successful. Deep waters around the 50 states have been imaged with sidescan sonar, and the production of maps, atlases, and electronic data disks is nearing completion for these regions. Plans are in place to complete the imaging of the seabed around the Pacific Islands by 1997. Availability of data from these activities has been communicated to potential users through biennial symposia and a newsletter.
- Surveying and mapping activities such as bathymetry, acoustic imaging, and reflection profiling are conducted by federal agencies (including the military), the states, academia, and various industries. There is little effort to coordinate such activities and organize and utilize complementary data sets.
- Attempts to take advantage of existing data are often frustrated by a lack of knowledge of what data have been collected, where they are stored, and how they can be accessed. The lack of common formatting standards makes it difficult for multiple users to access and use others' data.
- Competition and conflict exist in some cases between private and public sector data gathering and dissemination activities. Policies are needed that delineate the proper balance between the public need for information and the private sector's right to be free of unfair competition from publicly funded activities.
- Seafloor mapping technology has made rapid advances in the last few years and efficiencies have been greatly improved. However, there is considerable room for progress in developing technologies that can remotely or directly sample and identify attributes of sediments as needed for specific resource and site evaluations (e.g., lithology, ore mineral concentration, bed thickness, etc.).
- The greatest information needs of the users in the states, industry, and academia are for bathymetry, imagery, and seabed characterization. Most users are also interested in information about living resources, which is not presently included in the national EEZ research activities and was not within the scope of this investigation. The current USGS and NOAA EEZ activities programs are highly beneficial for providing seafloor imagery and bathymetric data (respectively) that are useful in a regional context. However, this information needs to be supplemented with additional data that can be used to provide a better assessment of resource potential or economic potential, to develop a better scientific understanding of the geologic processes that formed or are ongoing on the continental margins, and to assure an improved assessment of environmental conditions.
- There is a strong interest in the nearshore, shallow-water regions (<200 m) of the EEZ. Systematic exploration of this area will require technological systems that are fundamentally different from those used by the USGS and NOAA in the initial phase of their EEZ activities: new ships, towed instruments, and remotely operated vehicles that can be equipped with multiple geophysical, geochemical, and geotechnical sensors.
- One need common to all groups is informational in nature: digital database development and information management. The USGS and NOAA need to define their roles in establishing data gathering and data management standards, procedures, and guidelines for use by all organizations active in the EEZ. The databases of EEZ information should be easily accessible by a wide variety of users, yet the system should be flexible and capable of evolving to meet the changing needs of its clientele, as well as the opportunities afforded by new technological developments.
- Mechanisms are needed to involve the nonfederal users in a formal and ongoing process of providing direction, defining objectives, and setting priorities for federal EEZ activities.

3

PRESENT AND FUTURE EEZ ACTIVITIES:

CONCLUSIONS AND RECOMMENDATIONS

EEZ mapping and survey activities of the USGS and NOAA have been impressive, especially given the limits on funding, assets, and human resources. In general, however, the committee's investigations have confirmed the persistence of the problems diagnosed in a 1986 report to the President and Congress describing the national effort in the EEZ (NACOA, 1986):

> The present government EEZ effort is represented by a number of worthwhile programs which are making important contributions. However, NACOA finds that the present structure of programs, with each agency having objectives dictated by its own mission, is not acceptable. The benefits to the Nation could be extended by associating these efforts with a national plan. There is a need for a national scientific exploration program for the EEZ in order to satisfy data acquisition needs, reduce overlap, and increase fiscal responsibility. Such a plan would also provide a more certain environment for industry investment. There is no such plan now in existence nor is there any agency developing a coordinated plan. The general philosophy recommended by NACOA is to formulate a plan that builds on or redirects existing programs and activities and essentially does not require increases in government resources and personnel.

The current activities depend on individual efforts and assets that are, in many instances, borrowed or diverted from other projects. The long-term effectiveness of these ad hoc efforts of NOAA and the USGS is undermined without guaranteed continuance. Plans and priorities are set by those carrying out the information collecting activity, with no formal mechanisms for involving a larger body of coordinated state and federal agencies, industries, and researchers who require the information. State-of-the-art technology is generally not available, and the existing programs are handicapped by a decaying infrastructure of ships and computational facilities. The relatively small groups within each agency that plan and implement activities in the EEZ are struggling for survival in a time of federal cutbacks, and it is not clear that these programs have priority within either the USGS or NOAA. Visibility is low for ocean-related activities, in general, both in the eye of the public and in the attention of legislative bodies with influence over appropriations (MacDonald et al., 1991).

Yet, within the geographic context of the EEZ, user interest, driven by present and expanding needs, has continued to grow since the signing of the EEZ proclamation in 1983. Evolution of interest and needs is manifest in the reports of various government commissions and task groups; (NACOA, 1984, 1986; McClelland, 1985; OTA, 1987; NRC, 1989, 1990, 1991a) and involve basic economic, scientific, and environmental requirements that relate to the needs of users and potential users of the seabed. This investigation reveals a widespread interest in EEZ data by state government agencies that have responsibility for planning, managing, and regulation of economic activities projected to take place offshore a number of states in the near future. Particularly acute are concerns in many states for achieving a proper balance of environmental preservation and economic development.

Economic interest relates mainly to the resources--living and nonliving--on or within the seabed, or activities conducted that utilize the seafloor, such as communications cables and oil and gas pipelines. Industries have a less immediate interest, but many operations (e.g., oil and gas, communication cables,

and mining for aggregates) are contemplating expanded activities in EEZ regions in the future, and a process for cooperative partnerships between state and federal government and industry in acquiring seabed information would benefit all concerned. The utilization and proper management of these resources or activities represent new and long-term sources of wealth and opportunity for the nation.

Scientific opportunities include both basic and applied research through cooperative endeavors among state and federal government, academia, and industry, each functioning within its own appropriate sphere of responsibility. Scientific programs properly conceived and executed can provide a viable approach for resource/activity identification and development, as well as the means of wise utilization and conservation (NOAA/NSF Workshop, 1992). The broad realm of environmental studies ranges from identification and investigation of potential natural hazards to protection and mitigation of man-made effects.

These user interests also are in the national interest. Although market demand for seabed resources or expanded economic activities may be some years away, conservation and wise management of the ocean and its resources require public investment in information gathering activities with sufficient lead time to assess potential resources, develop technology, and devise environmentally sound management procedures.

CREATING A NATIONAL PROGRAM

CONCLUSION:

- ***While current federal budgets and foreseeable market conditions do not warrant a large-scale national EEZ program, a modest and sustained national effort is needed (1) to provide the basic information necessary to the long-term national interest in development of resources and wise stewardship of our ocean regions, and (2) to ensure that existing data are accessible and widely disseminated as needed. The national effort to acquire, analyze, and disseminate seabed information to meet user needs merits dedicated assets and human resources and stable funding.***

A coordinated and strategic seabed information program in the federal government can provide the technical basis for successful and environmentally sound utilization of this region and its resources in the future. It can provide the basis for federal and state regulations aimed at preserving the ocean as wilderness, where appropriate, or at fostering wise development of marine resources. A stable long-term program would provide a focus and a means to build a truly national effort in the EEZ--drawing on, developing, and promoting the best efforts of both the public and private sector brought together in a formal institutional framework capable of setting appropriate economic and environmental goals.

In its 1986 report (NACOA, 1986) the National Advisory Committee on Oceans and Atmosphere (NACOA) gave careful consideration to the leadership role in what they felt was an essential national plan. NACOA recommended that the USGS be designated to lead the federal effort for scientific exploration of the EEZ, with the expectation that NOAA would take a more active role "after the initial geological characterization of the EEZ. . ." was completed. The lead role envisioned by NACOA was one of coordination among agencies having EEZ programs, as well as evaluation of user requirements.

Although NOAA and the USGS did establish a mechanism to coordinate their EEZ activities, the USGS/NOAA Joint Office of Mapping and Research (JOMAR) has no national mandate and no direct allocation of resources. As a result it does not have the ability to bring about the cooperation and coordination of the many agencies and organizations with an interest in the U.S. EEZ, and it is dependent for its continued existence on resources, assets, and staff formally allocated to other USGS and NOAA programs.

RECOMMENDATION:

- ***A permanent program should be established for long-term seabed mapping and research activities and efficient dissemination of existing and future data products. The permanent program envisioned can be established through Congressional legislation, by Executive Branch mandate, or through internal agency actions. The essential elements are: unified management and operational structure; a dedicated, defined, and stable budget; guaranteed assets (e.g., ship time, instruments) and personnel; and formal participation by nonfederal users in planning and priority setting. The federal program should encourage a strong and competitive private sector component in ocean technology development, data gathering, and data dissemination activities.***

These activities need to be provided with a defined budget and guaranteed assets to carry out a sustained and coherent program of data gathering and dissemination activities to support the nation's long-term interests in exercising wise stewardship over the ocean and its resources. Because periodic reporting of program accomplishments to and oversight by the Congress will likely help to ensure continued support of this effort, the committee finds that federal authorizing legislation is the most effective route to accomplish these objectives.

WORKING TOGETHER

CONCLUSION:

- ***The expenditure of federal funds for mapping and research activities in the EEZ needs to become user driven in order to acquire the support needed to mount sustained and effective data acquisition activities and build an efficient data management and distribution system for national ocean information. Planning for future activities will benefit from structured and ongoing participation in program planning and oversight by all current and potential users, including states, industry, and academia, through an ongoing formally established mechanism or process, such as a task force.***

Except for biennial symposia, the present USGS/NOAA EEZ program has not actively sought to cultivate a constituency of users. Investigations leading to this report were the first step in identifying interests outside the federal agencies. The committee's investigations reveal that there is, in fact, an emerging constituency for a national EEZ effort. It is found primarily in agencies in the coastal states and territories that are gearing up for future management and development of offshore coastal regions. Many states are in the forefront of planning for expansion of economic activities in their coastal waters and have a strong interest in ensuring that environmental concerns are accommodated. To a lesser extent, industry and academia also have a long-term interest in particular kinds of data provided by a national program. For example, the oil industry seeks understanding of basic geologic processes in specific geographic regions for use in interpreting oil and gas prospects. The ocean science community is interested in data that will assist in understanding long-term ocean and seabed processes. The federal effort will be stronger and more valuable to the nation if it addresses the needs of these users; however, these communities need to become active participants in setting future directions and priorities before they will become enthusiastic and vocal supporters of federal EEZ mapping and research programs.

RECOMMENDATION:

- ***The U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA) should establish a formal program planning structure composed of representatives of nonfederal users of Exclusive Economic Zone information and data to plan scientific activities, design data management systems, and establish priorities for activities. This planning group should be linked to other federal agencies, both civilian and defense, that are conducting EEZ mapping, research, and data management activities.***

The surveys of various segments of the user community have revealed that interests in the EEZ are diverse and, consequently, information needs vary among users. The most effective program of EEZ information acquisition, management, and dissemination will involve a partnership of public and private organizations that jointly establishes goals and monitors progress. Partners should include several federal agencies (civilian and defense), coastal state governments, private firms, academic institutions, and public interest groups. A program planning mechanism that includes a process for involving potential users is needed at the outset of a truly national and coordinated program. Program planning can be used to establish priorities among objectives and to develop specific projects to optimize the efficiency and productivity of the program.

There are many examples of program planning mechanisms within the scientific community, including those embraced by the Ocean Drilling Program, the Continental Scientific Drilling Program, World Ocean Circulation Experiment, and a number of other national and international science programs. In general, these planning functions share a common feature--they are part of a much larger program hierarchy designed to include the interests of all program participants and information users.

The federal participants should include both civilian and military organizations that provide and use data from the EEZ. The National Oceanic and Atmospheric Administration, the Defense Mapping Agency, and the U.S. Navy are currently involved in an effort to coordinate their ocean data management efforts through the Defense Hydrographic Initiative. The civilian EEZ data and information management system could benefit from linkage to these ongoing efforts. State governments should be involved as data providers and users of such information.

The private sector participants should include resource development organizations and service industries. University participation should reflect institutions that are involved in oceanographic and coastal scientific and policy-related research and technology development. A broad spectrum of interest groups, including environmental organizations, should contribute to the design and implementation of the EEZ program.

Many nations are involved in research and mapping in their Exclusive Economic Zones and some countries conduct research and mapping outside their jurisdictions. The potential for international cooperation points toward an international component of an EEZ planning mechanism.

Involving all interested public and private organizations in program planning and in conducting the various activities will make it easier to establish priorities for data collection and to design an information system that meets user needs. These users can assist in oversight to ensure that progress is systematically measured and publicized.

Planning for future activities will benefit from structured and ongoing participation and oversight by all current and potential users, including states, industry, and academia through an ongoing formally established mechanism or process, such as a task force. The following are general guidelines for defining the planning body's role:

- Promote a continuity of national effort in the EEZ through guaranteed resources and assets.
- Address data management issues (see below).
- Encourage interagency cooperation use of limited resources, including facilities, platforms, and personnel.
- Encourage government/private sector partnerships for both technology development and specific projects.
- Seek congressional support for EEZ activities.

BUILDING AN INFORMATION MANAGEMENT SYSTEM

CONCLUSION:

- ***There is a need for a federally managed EEZ data and information management system that is aimed at providing access to data for a wide range of users--civilian and defense and public and private--rather than at simply archiving data.***

Data management issues need to be addressed as a first priority by the federal agencies with lead roles in EEZ activities and by the recommended task force or program planning body of EEZ information users. An active, easily accessible data management system for EEZ data is needed with the following aims:

- Seek to achieve a balance between the acquisition of new information through new projects and activities, and the dissemination of existing and historical data.
- Devise ways need to acquire non-proprietary seabed data from industry and unclassified data from the military in a manner that does not place large time and financial burdens on the contributor.
- Establish and enforce data standards to promote collaboration and data sharing among all users regarding data collection, processing, integration, and access.

RECOMMENDATION:

- ***Lead agencies for the seabed research and mapping program (the USGS and NOAA) should establish an access-oriented EEZ data and information management system that assures that existing and new information are brought into a unified system that is easily accessible to all users. Cooperative links should be formed with existing civilian and defense ocean data management, dissemination, and archiving projects.***

Building on existing data centers (the National Geophysical Data Center and the National Ocean Data Center), and working in conjunction with the Defense Hydrographic Initiative, federal agencies could become the keeper of a seabed information management system that provides easy access to data by all potential users.

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The committee's investigations have revealed that the nation needs an effective and sustained effort to collect, manage, and distribute information about the seabed of the Exclusive Economic Zone to meet requirements for a number of users of this information now and in the future. The coastal states and territories have indicated that this information is necessary to planning and managing wise conservation and appropriate development of their coastal areas. Offshore industries--such as the oil and gas and communication cable industries--are already venturing into the EEZ regions and depend on oceanographic, geologic, and geotechnical information for the identification of resources, project siting decisions, and construction of models for predicting the impacts on the surroundings of any development activity. The ocean research community uses data from federal EEZ mapping and research programs as the foundation for understanding basic ocean and seabed processes.

The responsible management of the nation's offshore areas will only be possible through the efficient collection and ready availability of an increasing volume of data. As the nation's priorities change with respect to utilization and protection of marine resources, it will be vitally important to have policy

decisions predicated on adequate information that can readily be obtained, integrated, and interpreted by a varied community of data users.

A stable, long-term national program for gathering information about seabed resources, hazards, and processes will require a partnership of data users and providers in order to target limited resources towards activities that will meet user needs and lead to the timely attainment of national goals for the ocean. Using the seabed to its full potential in a manner consistent with wise stewardship of the marine environment will involve investment of resources with a long lead time, but the benefits to the nation will be substantial.

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APPENDIXES

APPENDIX A

EEZ PROCLAMATION

Exclusive Economic Zone of the United States of America
A Proclamation by the President of the United States of America
March 10, 1983

WHEREAS the Government of the United States of America desires to facilitate the wise development and use of the oceans consistent with international law;

WHEREAS international law recognizes that, in a zone beyond its territory and adjacent to its territorial sea, known as the Exclusive Economic Zone, a coastal State may assert certain sovereign rights over natural resources and related jurisdiction; and

WHEREAS the establishment of an Exclusive Economic Zone by the United States will advance the development of ocean resources and promote the protection of the marine environment, while not affecting other lawful uses of the zone, including the freedoms of navigation and overflight, by other States;

NOW, THEREFORE, I, RONALD REAGAN, by the authority vested in me as President by the Constitution and the laws of the United States of America, do hereby proclaim the sovereign rights and jurisdiction of the United States of America and confirm also the rights and freedoms of all States within an Exclusive Economic Zone as described herein.

The Exclusive Economic Zone of the United States is a zone contiguous to the territorial sea, including zones contiguous to the territorial sea of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands (to the extent consistent with the Covenant and the United Nations Trusteeship Agreement), and the United States overseas territories and possessions. The Exclusive Economic Zone extends to a distance 200 nautical miles from the baseline from which the breadth of the territorial sea is measured. In cases where the maritime boundary with a neighboring State remains to be determined, the boundary of the Exclusive Economic Zone shall be determined by the United States and other States concerned in accordance with equitable principles.

Within the Exclusive Economic Zone, the United States has, to the extent permitted by international law, (a) sovereign rights for the purpose of exploring, exploiting, conserving and managing natural resources, both living and non-living, of the seabed and subsoil and the superjacent waters and with regard to other activities for the economic exploitation and exploration of the zone, such as the production of energy from the water, currents and winds; and (b) jurisdiction with regard to the establishment and use of artificial islands, and installations and structures having economic purposes, and the protection and preservation of the marine environment.

This proclamation does not change existing United States policies concerning the continental shelf, marine mammals and fisheries, including highly migratory species of tuna which are not subject to United States jurisdiction and require international agreements for effective management.

The United States will exercise these sovereign rights and jurisdiction in accordance with the rules of international law.

Without prejudice to the sovereign rights and jurisdiction of the United States, the Exclusive Economic Zone remains an area beyond the territory and territorial sea of the United States in which all States enjoy the high seas freedoms of navigation, overflight, the laying of submarine cables and pipelines, and other internationally lawful uses of the sea.

IN WITNESS WHEREOF, I have hereunto set my hand this tenth day of March, in the year of our Lord nineteen hundred and eighty-three, and of the Independence of the United States of America the two hundred and seventh.

Statement by the President
March 10, 1983

The United States has long been a leader in developing customary and conventional law of the sea. Our objectives have consistently been to provide a legal order that will among other things, facilitate peaceful, international uses of the oceans and provide for equitable and effective management and conservation of marine resources. The United States also recognizes that all nations have an interest in these issues.

Last July I announced that the United States will not sign the United Nations Law of the Sea Convention that was opened for signature on December 10. We have taken this step because several major problems in the Convention's deep seabed mining provisions are contrary to the interests and principles of industrialized nations and would not help attain the aspirations of developing countries.

The United States does not stand alone in those concerns. Some important allies and friends have not signed the Convention. Even some signatory States have raised concerns about these problems.

However, the Convention also contains provisions with respect to traditional uses of the oceans which generally confirm existing maritime law and practice and fairly balance the interests of all states.

Today I am announcing three decisions to promote and protect the oceans interests of the United States in a manner consistent with those fair and balanced results in the Convention and international law.

First, the United States is prepared to accept and act in accordance with the balance of interests relating to traditional uses of the oceans--such as navigation and overflight. In this respect, the United States will recognize the rights of other States in the waters off their coasts, as reflected in the Convention, so long as the rights and freedoms of the United States and others under international law are recognized by such coastal States.

Second, the United States will exercise and assert its navigation and overflight rights and freedoms on a worldwide basis in a manner that is consistent with the balance of interests reflected in the Convention. The United States will not, however, acquiesce in unilateral acts of others designed to restrict the rights and freedoms of the international community in navigation and overflight and other related high seas uses.

Third, I am proclaiming today an Exclusive Economic Zone in which the United States will exercise sovereign rights in living and non-living resources within 200 nautical miles of its coast. This will provide United States jurisdiction for mineral resources out to 200 nautical miles that are not on the continental shelf. Recently discovered deposits there could be an important future source of strategic minerals.

Within this Zone all nations will continue to enjoy the high seas rights and freedoms that are not resource-related, including the freedoms of navigation and overflight. My Proclamation does not change existing United States Policies concerning the continental shelf, marine mammals and fisheries, including highly migratory species of tuna which are not subject to United States jurisdiction. The United States will continue efforts to achieve international agreements for the effective management of these species. The Proclamation also reinforces this government's policy of promoting the United States fishing industry.

While international law provides for a right of jurisdiction over marine scientific research within such a zone, the Proclamation does not assert this right. I have elected not to do so because of the United States interest in encouraging marine scientific research within 200 nautical miles of their coasts, if that jurisdiction is exercised reasonably in a manner consistent with international law.

The Exclusive Economic Zone established today will also enable the United States to take limited additional steps to protect the marine environment. In this connection, the United States will continue to work through the International Maritime Organization and other appropriate international organizations to develop uniform international measures for the protection of the marine environment while imposing no unreasonable burdens on commercial shipping.

The policy decisions I am announcing today will not affect the application of existing United States law concerning the high seas or existing authorities of any United States government agency.

In addition to the above policy steps, the United States will continue to work with other countries to develop a regime, free of unnecessary political and economic restraints, for mining deep seabed minerals beyond national jurisdiction. Deep seabed mining remains a lawful exercise of the freedom of the high seas open to all nations. The United States will continue to allow its firms to explore for and, when the market permits, exploit these resources.

The Administration looks forward to working with the Congress on legislation to implement these new policies.

APPENDIX B

BIOGRAPHIES OF COMMITTEE MEMBERS

WILLIAM B.F. RYAN Chairman, is Doherty Senior Scientist at the Lamont-Doherty Geological Observatory of Columbia University. Dr. Ryan has served the Lamont-Doherty Geological Observatory since 1971 both as a research scientist and as Associate Director of the Marine Geology and Geophysics Division. He received his B.A. in Geology from Williams College and his Ph.D. in Geology from Columbia University. Dr. Ryan's research area is marine geology, with a focus on structure, volcanics, and tectonics of spreading centers of mid-ocean ridges and the geological evolution of the passive continental margins. In conjunction with his research, he has developed instruments for investigation the ocean floor, including multifrequency side-looking sonar instrumentation and deep-sea video and film camera instrumentation.

PETER T. LUCAS was General Manager of Exploration and Production Research and Development for Shell Development Company until his retirement. He holds B.S. and M.S. degrees in Geology from the University of Michigan. Mr. Lucas joined Shell Oil Company in 1954, where he had various geological assignments in their domestic exploration activities. In 1975, he was named Manager of Geology Research, followed in 1979 by an assignment as Chief Geologist in Shell Oil Company's Western Region. In 1980 he was named Director of Exploration Research for Shell Development Company, supervising Shell's research activities in geology, geophysics, and computer applications. In 1983, he was named Vice President of U.S. Shell's foreign exploration subsidiary. He moved to Shell's head office organization in 1986 as General Manager of Geology, and was named General Manager of Exploration and Production Research in 1987.

ROBERT R.P. CHASE is Director of Earth and Environmental Sciences at TASC in Reading, Massachusetts. He has a Ph.D. in physical oceanography and spent ten years at Woods Hole Oceanographic Institution, where he designed and replicated remote sensing image processing systems for marine data analysis. He does scientific research on large scale low frequency air/sea interactions, and, additionally, explores new methods for processing and distributing large geophysical data bases. Chase served on the NASA Space Station Advisory Committee and also serves as an adjunct Professor at the University of Colorado.

DONALD A. HULL is the State Geologist and Director, Oregon Department of Geology and Mineral Industries, where his responsibilities range from managing a scientific and technical staff engaged in the evaluation of energy and mineral resources to dealing directly with the Governor and the Legislature on various issues involving budget and policy. Prior to assuming this position, Dr. Hull worked the Homestake Mining Company, first as exploration geologist and later as a District Exploration Manager. He has a B.S., M.S., and Ph.D. degrees in geology.

JAMES D. (DON) MURFF is a member of the senior technical staff at Exxon Production Research Company in Houston, Texas, where he serves as Research Advisor to the geotechnical R & D program. He also has taught geotechnical engineering at Texas A & M University. Dr. Murff received a B.S. in Science and Engineering from the U.S. Military Academy and M.S. and Ph.D. degrees in Civil Engineering from Texas A & M University. From 1963-1968, Dr. Murff served as an officer in the U.S. Army Corps of Engineers on various international assignments, including active duty in Vietnam. Dr. Murff's research interests are in foundation engineering for offshore facilities used in oil and gas production, as well as foundation assessment for exploration activities.

C. BARRY RALEIGH is Dean of the School of Ocean and Earth Science and Technology and Professor of Geology. He was Director of the Lamont-Doherty Geological Observatory of Columbia University from 1981-1989. From 1966-1981, Dr. Raleigh served in a variety of positions at the U.S. Geological Survey, including Chief of the Branch of Earthquake Tectonics and Coordinator of the Earthquake Prediction Program. He holds a B.A. in Geology from Pomona College and an M.A. in Geology from Claremont College. His Ph.D. is in Geology and Geophysics and is from the University of Sciences and the Board of Ocean Studies. He is also a member of the Joint Oceanographic Institution Board of Governors and JOIDES Executive Committee. His research interests are in the area of earthquakes and tectonics, and he has broad interests and involvement in ocean resource and policy issues.

ROBERT C. TYCE is Associate Professor of Ocean Engineering and Oceanography at the University of Rhode Island. He is also Director of the URI Ocean Mapping Development Center. His research and professional interests are in the development of new oceanographic instrumentation and vehicles, and in improving the operations and capability of high resolution bathymetry technology. He has been principal investigator and research and chief scientist on numerous scientific expeditions funded by the U.S. Navy, the National Science Foundation, and the National Oceanic and Atmospheric Administration. Tyce has a B.A. in Physics, an M.A. in Computer Science, and a Ph.D. in Applied Physics/Applied Ocean Sciences. He has published extensively in the area of seafloor acoustics and mapping technology, and has also designed ocean instruments for a small corporation developing oceanographic instrumentation and software for seafloor mapping.

J. ROBERT WOOLSEY, JR. is Director of the Continental Shelf Division of The Marine Minerals Technology Center, which is half of a federally funded joint program operated by the states of Mississippi and Hawaii to develop technologies for exploration and mining ocean resources. Most of the projects of the Center are aimed at developing technologies and techniques for transfer to marine exploration and mining industries, and related graduate level training. Woolsey has extensive international marine resource development experience through his previous work with the United Nations Development Program and the United Nations Revolving Fund for Natural Resources Exploration. He holds B.S., M.S., and Ph.D. degrees in geology, marine science and engineering, and has conducted research on marine minerals deposits and related exploration and mining technology. He has worked as a consulting geologist and engineer for mineral exploration and mining firms in North America, South America, Southeast Asia, Africa, and the South Pacific.

ALAN G. YOUNG is President of Fugro-McClelland Marine Geosciences, Inc. He has a B.S. in Civil Engineering and an M.S. in Geotechnical Engineering. He has been instrumental in developing an integrated approach to marine projects in which a team of specialists in various areas of marine geosciences work closely together to prepare a single comprehensive study. His areas of special technical expertise include: (1) deepwater marine foundation studies, (2) foundation studies for mobile jack-up rigs, and (3) sediment strength interpretation for various sampling and in situ testing methods.

APPENDIX C

OUR SEABED FRONTIER: CHALLENGES AND CHOICES (NRC, 1989)

CONCLUSIONS AND RECOMMENDATIONS

The investigations of the committee resulted in two major conclusions about the future uses of the seabed in the Exclusive Economic Zone (EEZ). First, it is highly probable that the uses of this region will increase in the next 20 years. These include exploration for and development of oil and gas resources, waste disposal, emplacement of cables for civilian and military purposes, harvesting of fisheries resources, recovery of certain hard minerals, and designation of cultural resources such as marine sanctuaries. Potential uses of the EEZ seabed related to a broader spectrum of mineral exploration and development, other biological resources, development of ocean energy systems and technologies, and recreational uses are less likely to expand significantly in the near term, but will probably become more important in the time frame beyond 20 years.

The second major conclusion of this study is that for all foreseeable uses of the EEZ seabed, improved coordination and increased joint planning are needed to implement effective and efficient systematic mapping and surveying programs and develop or improve the technology needed to support them, improve access to and sharing of EEZ data, develop approaches for multiple uses, identify and resolve potential conflicts among various users, and ensure environmental protection. Such a strategy would provide the nation with the foundation for a coherent plan for developing its ocean territory.

In order to accomplish these objectives, the committee recommends the following actions be initiated:

COORDINATION AND PLANNING

Economic and institutional pressures will lead to increasing use of the U.S. EEZ seabed for a variety of purposes, some of which are likely to conflict. Additional planning efforts among federal and state governments, industry, academia, and representatives of public interest groups will lead to more efficient, orderly, equitable, and environmentally sound development of EEZ resources.

Recommendations

1. Congress should enact legislation that creates a formal joint planning and coordination process that includes a lead agency mandated to develop a national EEZ plan, an external commission composed of representatives of industry, academia, and public interest groups, and an internal interagency committee. Based on the recommendations and advice of the commission and interagency committee, and in cooperation with the coastal state governments, the federal government should formulate a national management policy for EEZ uses that identifies the needs of specific user groups and determines ways of enhancing cooperation and efficiency of operations among the various agencies and industries and identifying and resolving potential conflicts among them.

2. As part of the planning and coordination process, federal agencies with EEZ programs should pursue cooperative and joint agreements with coastal state governments in planning and implementing EEZ activities.

SPECIFIC USES

Certain uses of the EEZ will require special policy action at the federal level in order to plan for future development. For example, development of mineral resources and use of the EEZ seabed for waste disposal are potential activities that are unlikely to proceed until more comprehensive national policies are devised. Other uses, both existing and potential, will also benefit from improved regulatory policies.

Recommendations

3. The U.S. Congress should ensure that a coherent policy is developed that addresses specific concerns of industry and coastal states with regard to economic and environmental issues affecting the development of EEZ mineral resources. Appropriate agencies should provide the leadership to ensure development of the necessary science and technology for assessment, evaluation, and verification of critical hard mineral resources.
4. A comprehensive long-term national waste management policy based on an evaluation of waste disposal in all media, including land and ocean disposal options, should be formulated by Congress to provide a predictable framework for planning and developing acceptable ocean waste management strategies.

RESEARCH AND TECHNOLOGY DEVELOPMENT

The seabed of the EEZ is a new frontier that includes a broad range of seafloor morphology, water depths, sediment types, and environmental conditions that affect its use. The complexity of the EEZ seabed requires multidisciplinary research efforts that are costly in terms of both technology and time required to obtain and analyze data.

The various potential uses of the EEZ share the need for reconnaissance survey data and for task and site-specific information. The variety of acoustic and optical technologies for collection of bathymetry, bottom imagery, and near-surface sedimentary data are costly in time and resources. The mapping priorities and geographic areas of interest in the EEZ require further definition as a first step toward planning the efficient sharing of mapping activities, survey and ship time, and equipment. Deepwater areas of known or potentially high resource value and other potential uses should have higher priorities than those areas for which no use is envisaged in the foreseeable future.

Recommendations

5. Research activities in the EEZ should be coordinated through a designated agency to enhance cooperation and efficiency of operations among various agencies, industries, and academia, and promote basic research efforts that will increase understanding of seabed processes in the EEZ.
6. As a part of the national EEZ plan, a formal government/industry/academia EEZ program should be established to set priorities for seabed surveying and mapping activities and promote the development of technologies for obtaining EEZ seabed data. The technological developments should include expanded use of multisensing systems for both task-specific and reconnaissance surveys in frontier areas, use of autonomous and towed vehicles, and improved techniques for processing and interpreting remotely acquired seabed data.
7. The agency designated to coordinate EEZ research activities should ensure that programs are set in place to develop the necessary technology for geotechnical and geological data acquisition in concert with the projected uses and needs. These systems and techniques will include improved sampling and

in situ testing equipment for use from surface and submerged vessels in frontier areas, field monitoring of installations, and laboratory experimental modeling for seabed-structure interaction studies.

8. Government should provide leadership in fostering communication and exchange of data among all agencies and other organizations conducting research in the EEZ through development of a comprehensive EEZ data management system.

ENVIRONMENTAL MONITORING

A clear need has emerged for a nationally coordinated and supported effort in monitoring selected portions of the EEZ seabed in connection with future uses. As EEZ expands, the lack of such a program will increase the risk of inadvertent and unacceptable damage to the EEZ environment. The required monitoring will fall into three categories: (1) reference monitoring to determine the natural range and variability of environmental parameters of the EEZ seabed, (2) process-related monitoring to understand major EEZ seabed processes, and (3) use-related monitoring to evaluate the suitability of EEZ sites for specific uses and their environmental consequences.

Recommendation

9. In conjunction with the joint planning and coordination process and the research efforts recommended above, a national EEZ monitoring program should be established with input from industry; federal, state, and local governments; academia; and public interest groups to determine EEZ monitoring priorities and strategies and the commitments by government and users required to implement them. Such a program should be based on the framework of projected uses of the seabed and should include long-term reference monitoring, seabed process-related monitoring, and use-related monitoring at specific sites. It should also incorporate the capability to respond to detrimental impacts.

PROTECTION OF UNIQUE AREAS

Identification and protection of unique underwater areas and habitats under the National Marine Sanctuaries Program has to date been a limited effort. In order to designate and subsequently manage a marine sanctuary, a substantial amount of information is needed on the resources and physical environment of the area.

Recommendation

10. Federally sponsored EEZ activities should include a marine sanctuary reconnaissance component for discovery and identification of unique areas of the seafloor deserving such long-term protection. Such designations should occur well in advance of resource development in EEZ areas to forestall potential conflict among competing uses.

APPENDIX D

INTERIM REPORT OF THE COMMITTEE ON EEZ INFORMATION NEEDS—COASTAL STATES AND TERRITORIES

The Coastal States and Territories

The first phase of the investigation was aimed at determining the needs and priorities of the coastal states and territories for information about the EEZ seabed in relation to plans for developing or preserving their coastal resources and waters.

A questionnaire on "EEZ Seabed Uses and Information Needs" was mailed to 72 offices in 23 coastal states and 5 U.S. territories, including state geologists, coastal zone management offices, and other agencies with jurisdiction over the state's or territory's offshore areas. The purpose of the questionnaire was to identify the needs of coastal states and territories for scientific information about the seafloor of the EEZ in relation to their environmental concerns and plans for economic development activities in their offshore areas. In addition to filling out a table ranking information needs by categories of expected uses, the respondents were asked to indicate the most crucial locations for present or future interest in the seabed and the reason for interest in that area.

A total of 52 responses were received from all 23 states and 3 out of 5 territories (the Marianas Islands and American Samoa did not respond). The responses were tabulated and aggregated by region in order to summarize plans for present and future uses and preferences for information in a manner useful for planning mapping and research activities. The results of this phase of the study was published in an interim report (NRC, 1990). The findings and conclusions, questionnaire, and analysis of responses follow.

FINDINGS AND CONCLUSIONS

GENERAL FINDINGS

- Resources for mapping and research in the EEZ are limited and many decades will be required to adequately document and map the entire EEZ. It is essential to establish priorities by data type and location.

- Users of EEZ information have diverse information needs and wide-ranging geographic emphasis—often site specific. Emphasis on principal *uses* of data rather than individual *users* of data is a more manageable approach in these circumstances.

- The priority of concerns of the coastal states and territories in relation to present or future uses of their offshore areas are:

1. biological resources (including fisheries),
2. mineral development (including sand and aggregates),
3. environmental assessment (including waste monitoring),
4. oil and gas development, and
5. shoreline management.

Of lesser concern are data for geohazards, cables, pipelines, cultural, recreational, ocean energy, and military uses.

Because these reports are intended as advice to JOMAR in relation to ongoing mapping and research programs, the focus of attention is on data related to geology, mapping, and bathymetry and on non-living resources. Consequently, living resources (such as fisheries) and biological information are not included in the committee's analysis of priorities for information about the EEZ.

DATA TYPE PRIORITIES OF EEZ ACTIVITIES

- Priority of data required varies with both type of use and stage of development. Generalizing from the lumped results, the overall priorities were as follows:

1. bathymetry,
2. characterization and distribution of the bottom sediments,
3. seafloor imagery,
4. high-resolution seismic profiles, and
5. geophysical data, especially deep seismic profiles.

The committee is not prepared to consider questions about allocation of resources for existing or future activities in the EEZ at this time, but has focused its efforts on determining the substantive (rather than quantitative) needs for data. Consequently findings and conclusions refer to the priority need for *new* categories of data, rather than whether ongoing activities such as bathymetry and seafloor imagery need to be modified.

- Sediment sampling and analysis is presently laborious, expensive, and slow. Automated techniques capable of supplying such data would entail substantial reductions in cost and improve standardization of output and should be explored.

- Sediment characterization by sampling should be preceded by systematic shallow penetration high-resolution seismic profiling. The samples to be taken then should be collected along a subset of the profiles to permit extrapolation of sediment properties by the relationship of acoustic signature.

Conclusion: Based on the state responses and independent committee analysis of information needs, the next systematic emphasis of data gathering should be on bottom sediment characterization (including associated high-resolution near-surface profiling), while ongoing programs on bathymetry and bottom imaging are pursued to satisfactory completion. Although this is a labor-intensive and time-consuming phase of data gathering and analysis, it provides essential ground truth calibration for remote measurement technologies. Strategies for best accomplishing this task, either on a site-specific or regional basis, must be further evaluated.

GEOGRAPHIC FOCUS OF EEZ ACTIVITIES

- The concerns of the coastal states and territories are focused on potential uses for the EEZ that are likely to take place offshore highly populated urban coastal cities and regions. This is particularly true with regard to waste disposal, recreational and cultural uses, and interests in shoreline management and environmental assessment. Oil and gas and hard mineral resources, on the other hand, are found in specific regions of the EEZ related to geologic rather than onshore cultural factors.

- These findings lead to three alternative approaches for collecting data: (1) selecting corridors or swaths extending from the shore to the EEZ boundary encompassing areas of expected high-intensity use;

(2) assembling data randomly through time at individual sites of special interest; or (3) choosing coast-wise oriented blocks encompassing areas of greatest intensity of state and industry interest.

- Since the EEZ mapping and research activities can be viewed as addressing the longer-term objectives and fundamental information needs of the nation, the strategy of assembling a data base solely on site-specific activities is not a sound approach. It would not provide the advantages of consistent, standard data and the more representative coverage provided by the other two approaches. The corridor approach assures a more balanced representation of technical and economic interests, coherence of data, and a systematic publication format. Coast-wise oriented blocks satisfy some of the same benefits as corridors and place emphasis on areas of maximum current interest. However, the coastal focus would not provide for coverage of important, but less popular interests, which extend to the deepwater boundaries of the EEZ. On balance, representative corridors are the preferred approach.

Conclusion: While each state or territory prefers a focus on the blocks offshore their particular coastline, the committee must take a broader perspective. From the committee's overall investigations it concludes that the most effective focus for information gathering activities in the EEZ is on corridor swaths extending from the shoreline to the EEZ boundary as a first priority.

DATA MANAGEMENT ISSUES

- A fundamental prerequisite to the effective use of limited resources is the definition and implementation of a well thought out and carefully designed data and information system to support the acquisition of new data and the management of existing data. It is imperative that this data system be complete, ranging from data acquisition through distribution to end users in forms and formats suited to their needs.

- To be efficient, modern information systems practices should be employed in the design of the supporting data and information system. If properly designed, the resulting data system will be modular and employ internationally accepted standards at the interfaces, yielding a flexible and evolvable system that readily supports changes in user needs as well as technology. System changes and evolution will then occur at costs far less than those associated with hardware-dependent designs.

- There is a need for improvements in the technical capability to acquire seabed data, given the areal extent of the EEZ and the limited resources for characterizing the seabed. In particular, bathymetric mapping technology at scales useful for the potential applications, needs improvement in swath width for shallow seas. Acoustic imagery in shallow coastal environments also needs technical and data processing improvements.

- To ensure that the data system is of utility to the end users, it should be user-transparent. All data should be maintained in digital form and archived and retrievable to *all* users in various forms and formats ranging from raw through gridded products. Although processed, interpretive products are useful for most classes of uses, these products should not be the sole form in which these data are made available. This implies that the supporting data and information system should have distribution subfunctions that include (but are not necessarily limited to) geographically-oriented data base management and reformatting functions.

- Descriptive information documenting or giving the "pedigree" of the data (such as location, sensor and processing parameters, acquisition time, calibration data, formatting options, etc.) should be appended to an archival data catalog and made available to users. To be of greatest utility, this information should be made available on line by remote users.

Conclusion: An issue of high priority for properly establishing a responsive and effective national data program for the EEZ is the definition and implementation of a complete data and information system. This system must support data acquisition, preprocessing, display, distribution, archival, and applications-oriented processing. To be efficient, the requisite system must be user transparent and support change in user requirements and evolution in technology. The development and implementation of this system must be accompanied by investment in requisite sensor technology and in the actual acquisition of data that will "feed" the system.

QUESTIONNAIRE

GUIDE TO TABLE ON EEZ SEABED USES AND INFORMATION

Instructions: Please rate your state's/territory's need for information by each category of use and type of data in terms of (1) essential (2) useful (3) background. Essential would include uses that are presently underway or planned in the near future. Useful would include uses under consideration in a longer-term time frame. Background would imply a general interest in information, but that is unlikely to be relevant to present or planned uses.

Please answer the following question for your state/territory:

What specific offshore geographic area(s) are the most crucial locales for your state's/territory's present or future interest in the seabed and why?

LOCATION(S)	REASON(S)
_____	_____
_____	_____
_____	_____
_____	_____

DEFINITION OF DATA GATHERING TECHNOLOGIES:

Bathymetry: The measure of ocean water depth obtained by sonars mounted on a ship's hull to measure travel time for sound to bounce off the seafloor and return to the ship. Bathymetric systems provide accurate water depth, and an accurate map of seafloor topography, but do not provide data on sediment type or thickness or show very small geologic features or objects on the bottom.

Sea Floor Imagery: Side-looking (or side-scan) sonars provide acoustic images of a swatch of the seafloor, showing morphology (bottom topography), sediment type and distribution, and small geologic features showing geologic processes.

Seismic Profiling Systems: Profiling systems are used to acquire information on water depth, seafloor profiles, and substrata sediment geometry, and stratigraphy. Near-surface and deep penetration profiling systems provide different levels of detail and resolution and operate at different depths below the seabed.

Bottom Sediment Characteristics: Various properties of seabed sediments and rocks can be determined using various direct sampling techniques, including sediment grabs and dredges for surface materials, and boring, coring, probing, or drilling for subsurface samples as well as bottom photography. Characteristics of the retrieved materials can then be mapped. Spatial integrity of the maps is directly related to sampling density because of seafloor and subsurface variability between sampling sites. Sediment types, mineral deposits, and geotechnical properties inferred through other types of survey data are typically confirmed using direct sampling.

EEZ SEABED USES AND INFORMATION NEEDS

Use	Tasks	Bathymetry		Sea Floor Imagery		Near-surface Seismic Profiles		Deep Penetration Seismic Profiles		Bottom Sediment Characteristics		
		Recon	Site specific	Recon	Site specific	Recon	Site specific	Recon	Site specific	Recon	Site specific	
Oil & Gas	Reserve Assessment Drilling Geohazards Facilities Siting											
Minerals	Reserve Assessment Geohazards Production Siting											
Waste Disposal	Site Selection Emplacement Monitoring											
Pipelines	Route Selection Installation Survey											
Cables	Route Selection Installation Survey											
Military												
Biological Resources	Habitat Assessment Monitoring											
Ocean Energy	Site Selection											
Shoreline Management	Location Stabilization											
Cultural Resources	Archaeology Sanctuaries Underwater Recreation											
Research	Structure Geologic Framework Process Studies											
Environmental Assessment	Baseline Studies											

Recon = Reconnaissance

Instructions: Please rate as follows:

1. Essential 2. Useful

ANALYSIS OF RESPONSES TO QUESTIONNAIRE

FIGURE 1: Responses to Questionnaire*

EEZ SEABED USES AND INFORMATION NEEDS

Use	Tasks	Bathymetry		Sea Floor Imagery		Near-surface Seismic Profiles		Deep Penetration Seismic Profiles		Bottom Sediment Characteristics		
		Recon	Site specific	Recon	Site specific	Recon	Site specific	Recon	Site specific	Recon	Site specific	
Oil & Gas	Reserve Assessment Drilling Geohazards Facilities Siting	6/11	12/10	9/10	10/9	10/10	10/8	10/13	11/8	6/10	9/6	
Minerals	Reserve Assessment Geohazards Production Siting	15/5	17/8	14/15	16/8	15/11	19/6	7/7	6/8	19/8	19/7	
Waste Disposal	Site Selection Emplacement Monitoring	11/14	17/8	9/13	18/7	6/11	6/8	3/7	4/5	12/10	18/10	
Pipelines	Route Selection Installation Survey	8/17	14/8	9/5	15/7	7/16	10/6	3/5	3/4	7/16	13/8	
Cables	Route Selection Installation Survey	6/14	10/6	6/11	10/6	3/13	8/5	1/3	2/2	4/11	10/6	
Military		2/4	2/1	2/4	3/—	1/2	1/—	—/1	—/—	1/3	2/1	
Biological Resources	Habitat Assessment Monitoring	17/12	15/8	13/16	14/10	7/7	4/5	2/5	1/4	16/13	18/6	
Ocean Energy	Site Selection	6/6	5/5	3/6	5/6	2/5	3/7	1/5	3/3	1/8	3/8	
Shoreline Management	Location Stabilization	16/17	21/6	9/16	12/10	8/11	8/8	2/5	1/2	16/11	21/5	
Cultural Resources	Archaeology Sanctuaries Underwater Recreation	10/14	13/11	10/14	11/11	4/12	6/7	—/5	—/3	7/14	11/11	
Research	Structure Geologic Framework Process Studies	15/13	15/8	15/10	18/6	14/11	19/4	15/9	17/4	14/12	16/10	
Environmental Assessment	Baseline Studies	16/15	17/6	13/13	13/9	8/12	6/9	7/5	5/4	13/15	15/10	

Recon = Reconnaissance

Instructions: Please rate as follows:

1. Essential 2. Useful

*Left number = 1 ("essential")
*Right number = 2 ("useful")

FIGURE D-1

FIGURE 2: Weighted Responses and Totals*

EEZ SEABED USES AND INFORMATION NEEDS

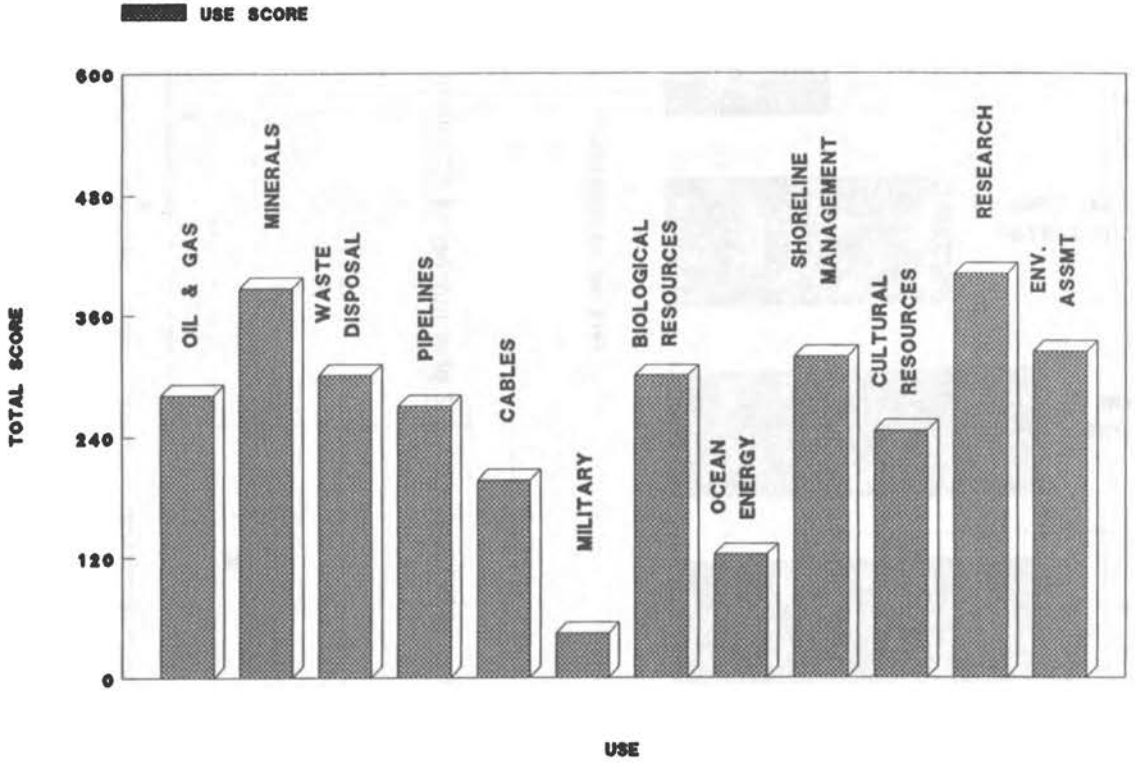
Use	Tasks	Bathymetry		Sea Floor Imagery		Near-surface Seismic Profiles		Deep Penetration Seismic Profiles		Bottom Sediment Characteristics		Totals
		Recon	Site specific	Recon	Site specific	Recon	Site specific	Recon	Site specific	Recon	Site specific	
Oil & Gas	Reserve Assessment Drilling Geohazards Facilities Siting	23	34	28	29	30	28	33	30	22	24	281
Minerals	Reserve Assessment Geohazards Production Siting	45	42	43	40	41	44	21	20	46	45	387
Waste Disposal	Site Selection Emplacement Monitoring	36	42	31	43	23	20	13	13	34	46	301
Pipelines	Route Selection Installation Survey	33	36	23	37	30	26	11	10	30	34	270
Cables	Route Selection Installation Survey	26	26	23	26	19	21	5	6	19	26	197
Military		8	5	8	6	4	2	1	—	5	5	44
Biological Resources	Habitat Assessment Monitoring	46	38	42	38	21	13	9	6	45	42	300
Ocean Energy	Site Selection	18	15	12	16	9	13	7	9	10	14	123
Shoreline Management	Location Stabilization	49	48	34	34	27	24	9	4	43	47	319
Cultural Resources	Archaeology Sanctuaries Underwater Recreation	34	37	34	33	20	19	5	3	28	33	246
Research	Structure Geologic Framework Process Studies	43	38	40	42	39	40	39	38	40	42	401
Environmental Assessment	Baseline Studies	47	40	39	35	28	21	19	14	41	40	324
Subtotals:		408	401	357	379	291	271	172	153	363	398	
Totals:		809		736		562		325		761		

Recon = Reconnaissance

*Number of "1" (essential) x 2 plus Number of "2" (useful)

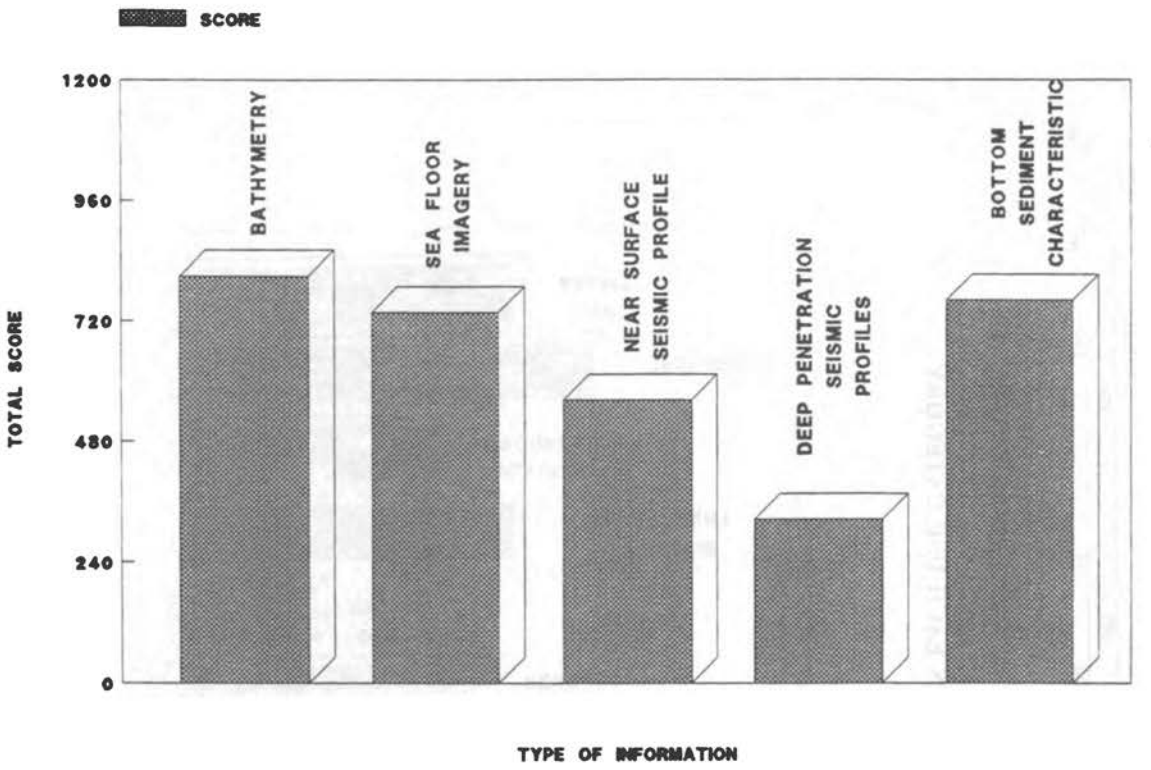
FIGURE D-2

FIGURE D-3: TOTAL SCORE* IN EACH USE CATEGORY



*Number of "1" (essential) x 2 plus number of "2" (useful)

FIGURE D-4 : TOTAL SCORE* IN EACH INFORMATION NEED FOR ALL REGIONS



*Number of "1" (essential) x 2 plus number of "2" (useful)

FIGURE D-5: Identified Concerns Of The States

USES OF DATA BASED ON COMMENTS IN STATE AGENCY RESPONSES.

		Shoreline Mgmt.	Environment and Waste Monitoring	Biologic Resources and Fisheries	Minerals, Placers and Aggregates	Oil and Gas Appraisal and Development	Cables and Pipelines	Geohazards	Waste Disposal	Cultural/Recreation	Ocean Energy	Military
Pac. Is.	Pac. Islands											
	Hawaii	X	X	X	X		X				X	
Alaska	Alaska N	X				X						
	W			X	X	X				X		
	S									X		
Pacific	Wash	X	X	X		X						
	Oregon		X	X	X	X			X			
	Calif N		X	X	X			X				
	S		X	X	X	X		X				
Gulf/Islands	Texas		X			X	X					
	Louisiana	X			X	X						
	Mississippi			X	X	X						
	Alabama					X	X					
	Florida W		X		X							
	E		X		X							
	P. R. and V. Is.	X	X	X	X	X	X	X			X	
South Atlantic	Georgia	X		X	X							
	S Carolina	X		X	X							
	N Carolina			X	X	X	X					
	Virgina				X	X						
	Maryland		X	X					X			
	Delaware	X		X								
North Atlantic	N Jersey	X	X		X							
	New York				X	X						
	Conn			X	X	X						
	Rhode Is		X	X								X
	Mass	X		X	X	X						
	N Hamp			X	X					X		
	Maine	X	X	X	X				X			X
	Total*	11	11	17	18	14	5	2	3	2	2	2

* One per state

FIGURE D-6: Data Types Required By Various EEZ Applications Forced Ranking (1 to 5) to Determine Highest and Strong Interest

Application Class → / Data Type ↓	Shoreline Mgmt.	Environment & Waste Monitoring	Biological Resources & Fisheries	Deep Sea Minerals	Continental Shelf Minerals	Oil and Gas Assessments	Oil and Gas Development	Pipelines	Cables	Geohazards	Waste Disposal	Cultural/Recreation	Ocean Energy	Military
Bathymetry	2	2	3	3	1	5	2	1	1	1	1	1	2	1
Seafloor Imagery		5	4	5		4		2	2	4	3	2	4	5
Sediment Characterization	1	1	1	1	2	2	1	4	4		4		3	2
Near-Surface Profiling	3	3		2	3		3	3	3	2	2	4	1	4
Geophysics — Deep Multichannel Seismic						1	5		5	3				
Bottom Sensing	4	4	2		4			5			5		5	3
Optical Imagery			5	4								3		
In Situ Testing							4							
Borehole Logging						3								

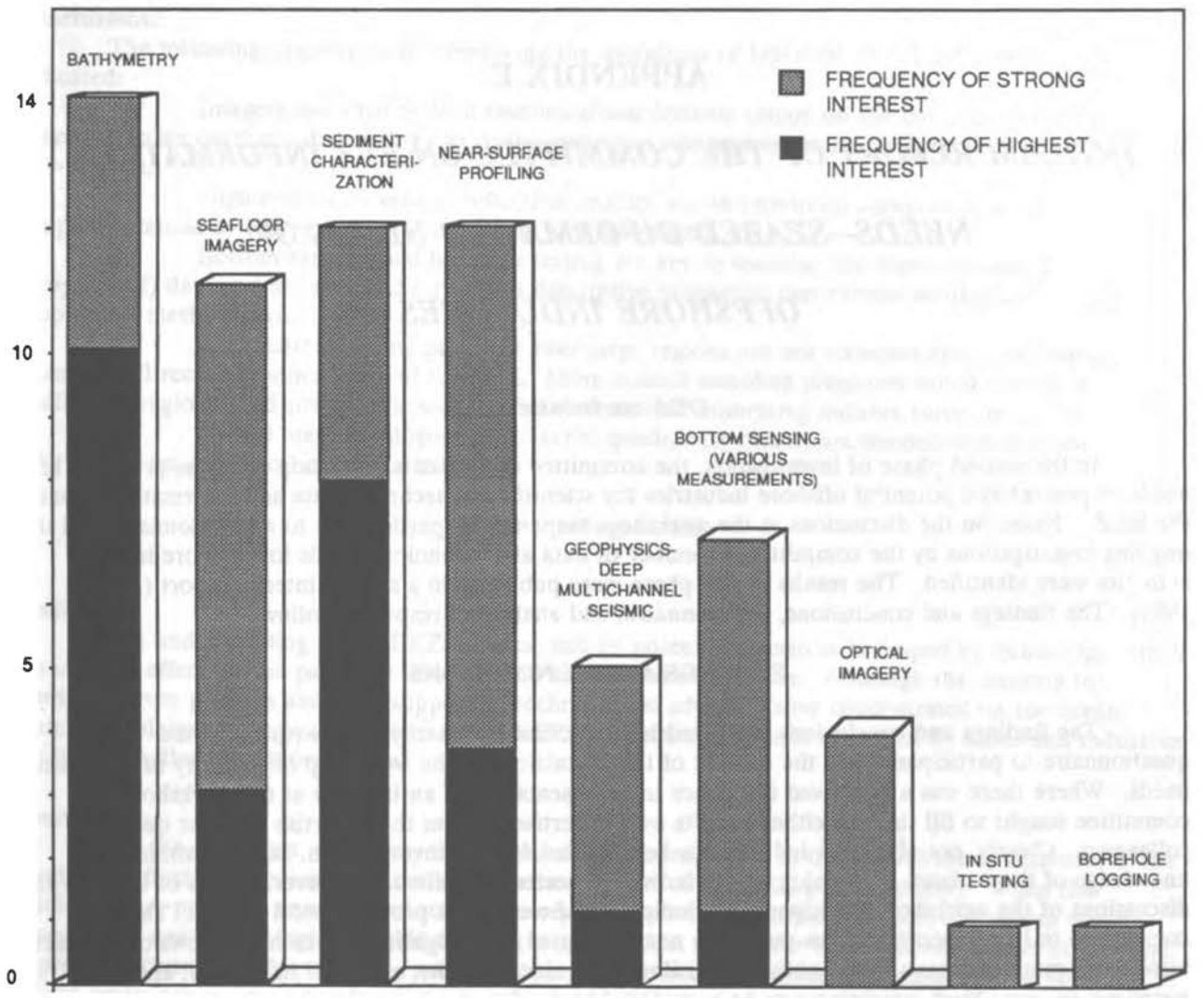


FIGURE D-7: Relative Frequency of Data Type Required by Principal EEZ Uses
Committee Judgment by Forced Ranking

APPENDIX E

INTERIM REPORT OF THE COMMITTEE ON EEZ INFORMATION NEEDS—SEABED INFORMATION NEEDS OF OFFSHORE INDUSTRIES

Offshore Industries

In the second phase of investigation, the committee conducted a workshop to assess priorities and needs of present and potential offshore industries for scientific and technical data and information about the EEZ. Based on the discussions at the workshop, responses by participants to a questionnaire and the ongoing investigations by the committee, a number of data and technology needs for offshore industry activities were identified. The results of this phase were published in a second interim report (NRC, 1991). The findings and conclusions, questionnaire, and analysis of responses follow.

FINDINGS AND CONCLUSIONS

The findings and conclusions presented here are based primarily on the results of the questionnaire to participants and the content of the discussions at the workshop on industry information needs. Where there was a perceived imbalance in representation of an industry at the workshop, the committee sought to fill the gap either with its own expertise or from the expertise of other qualified colleagues. Clearly, not all of the industry has been polled for this investigation, and the committee's knowledge of the variance of opinion within individual sectors is limited. However, results of the poll and discussions of the workshop participants are indicative of trends and provide useful insight. The committee, in its deliberations, has purposely not attempted any weighting in which the views of one sector were given more emphasis than another according to its size, maturity, extent of its activity, and its economic output. Such weighting may be considered in the future when priorities are given due consideration. Hence, the findings and conclusions presented below are preliminary. Recommendations for specific actions will be made after the completion of all phases of the investigation.

Data Needs

Findings:

The data types ranked as essential by industry for a systematic federal survey program include bathymetry, imagery, and characterization of the seabed with a limited number of calibration sample sites. These priorities were similar to those documented by the survey of the coastal states.

Conclusions:

The following suggestions for improving the usefulness of USGS/NOAA EEZ activities are indicated:

- Imagery collected by high-resolution side-looking sonars on the continental shelf could benefit from an overlap with existing reconnaissance-scale side-looking sonar imagery obtained from 200 m to >5000 m.
- High-resolution seismic reflection profiles are an important component in integrating samples obtained by coring/testing with imagery and bathymetry.
- Bottom samples and borehole testing are key to verifying the remotely sensed (geophysical) data and are required for certain descriptive properties that cannot be obtained through geophysical methods alone.
- Systematic sampling programs over large regions are not economically justifiable as part of an overall reconnaissance study of the EEZ. More limited sampling programs would be beneficial to small-scale regional and site specific studies, and essential for calibrating indirect survey methods.
- Seabed maps (analogous to subaerial quadrangle sheets) are needed with detailed information on geological characteristics.

Technology Needs

Findings:

The understanding of the EEZ, its uses, and its potential resources is shaped by technology, which has a direct effect on the pace, the location, and the cost of exploration. Although the majority of previous survey projects and their supporting technological advances have concentrated on the ocean basins and plains in deepwater regions of the EEZ, the primary interests expressed by states and industries are in the shallow nearshore regions.

Conclusions:

For the most part, the survey instrumentation presently used in the federal survey activities is not capable of effectively covering the shallow nearshore sector of the EEZ (<200 meters). When the USGS/NOAA program moves to substantial survey activity on the continental shelf, investment will be necessary in new technologies capable of being more efficient in shallow water. Development of new and improved technologies for exploring and developing the seabed's resources and evaluating the complex subsea environment requires advanced scientific and engineering expertise, incurs a high level of risk, and is costly. However, it is likely that a number of economic and technological benefits would accrue to the nation from partnerships between the public and private sectors for the capitalization of these new technologies. The following general technology needs were identified at the workshop:

- accurate, simple, and inexpensive subsea navigation systems that could be deployed beneath the sea surface;
- small unmanned vessels equipped with multiple geophysical, geochemical, and geotechnical sensors that could be deployed, controlled, and monitored in groups over large areas from a single command ship for maximum and timely reconnaissance data-gathering efficiency;
- new high density power sources for remote technologies;
- seafloor sampling tools that could be deployed rapidly, be remotely operated from the support vessel, have short turn-around times, give maximum representative sample recovery, and work in both unconsolidated and hard rock substrata to penetration depths exceeding ten meters.
- for improved shallow water capability, swath bathymetric and imaging systems capable of providing lateral coverage of several times the water depth, possibly encompassing multispectral sensors.

Data and Information Management

Findings:

The one need common to all industries surveyed is the requirement for the development of an electronic data system that would be easily accessible, could accommodate historical, as well as newly collected data, and would be flexible to keep it as complete and up-to-date as possible.

Conclusions:

While the determination of specific user requirements and the actual design of an appropriate EEZ data and information system is beyond the scope of this investigation, it is clear that such a system needs to be dynamic, evolving to meet the needs of its changing clientele, and capable of advantageously employing new technological developments. The following guiding principles are important to the development of an evolutionary data system:

- Involve the end user community at the outset and throughout all subsequent activities through a representative group of active users with oversight and review responsibilities, since the most successful examples of database management involve user oversight.
- Establish formats, standards, and guidelines at all levels, beginning with data acquisition, as early as possible and update them as often as needed.
- Begin planning and implementing an evolutionary EEZ data and information management system as early as possible for maximum benefits.

Program Implementation

Findings:

The public sector role focuses on long-term, multidisciplinary, reconnaissance-scale mapping and research. The private sector will generally direct its effort into more applied site-specific endeavors. However, a substantial amount of basic research is supported by industry. The public sector assists the private sector by setting standards, by the timely communication of important information (particularly in relation to regulation), and by providing services and products (navigational aids, warnings of hazards, data/information systems, and maps).

In some cases, the public sector and the private sector compete with each other. This is particularly perceived to be a problem by offshore service companies that provide survey products, weather and wave modelling/predictions, drilling/sampling, geological analyses, and data and information management. The products and services of the private sector are for sale on a profit basis, whereas the public sector provides products and services on a subsidized or cost-reimbursable basis.

Conclusions:

A successful national program for exploring and understanding the EEZ will require cooperation among all major participants in activities in this region: federal agencies, the coastal states, offshore industries, and the ocean research community.

- It is in the nation's interest to encourage the successful development of the U.S. ocean technology and service industries, possibly through partnerships for capitalization and deployment of new technologies.
- Instead of seeking public sector capability in every area, it may be more cost-effective for the government to identify the national interests that can best be served by contracting specific tasks to the industry.
- The public sector can foster cooperative relationships among industry, academia, and government by sponsoring and participating in joint research projects, promoting data standardization, maintaining data repositories, supporting professional society involvement, and promoting technology transfer.

- Priorities for federal surveys could be set and updated through a structure of advisory panels that include representatives of all EEZ users (federal, state, industry, and academia). The expertise of such panels could also be useful in defining standards, procedures, and protocols for EEZ data acquisition and management activities. Such collaboration could become a catalyst for cooperative projects between the private and public sectors.

QUESTIONNAIRE

Name _____ Company/Organization _____

Telephone Number _____ Address _____

Fax Number _____ State/Zip _____

EEZ INFORMATION NEEDS SURVEY

Please respond to the following questions.

1. Use of desired data? (Applications such as waste disposal, laying cables, mining aggregate, etc.) _____

2. List types of institutions potentially participating in the identified use. (such as mining company, municipal waste company, etc.) _____

3. Approximate number of potential business or institutional user participants in the identified application. Business: _____ Institutions, Gov't. : _____

4. What data types are required for each identified use?
   (A) Rank 1 thru 10.
   (B) Identify those essential - "E", useful - "U", little or no need - "NI".
   (C) Identify preferred future data aquisition systems or methods.

Measurement	A Rank 1.2.3....	B Value E/U/NI	C Acquisition system or method
Bathymetry			
Acoustic imagery (1)			
Near surface profiling (2)			
Sediment characterization			
Borehole logging			
In situ testing a) Geochemical b) Mechanical			
Bottom sensing			
Optical imagery			
Geophysics: seismic gravity magnetics			
Other (e.g. Radiation)			

(1) Such as side-looking sonar

(2) Such as shallow penetration high resolution seismic–single or multichannel.

5. Related to your principal application objectives, rate the value of regional framework sea bottom sampling. (Mark X)

	Essential	Useful	Background	Not wanted except site—specific locations
Seabed samples only				
Subbottom profiles only				
Samples located on profile lines				

6. For your objectives indicate maximum acceptable spacing of sample points in a regional framework study* which would include a mix of core and grab methods within a framework of high resolution profiles. (Mark X)

Water Depth Location		Spacing under 1KM	1 to 2KM	2 to 10KM	10 to 100KM	Comment
Under 50M	Line spacing					
	On-line grab samples					
	Core spacing					
Under 200M	Line spacing					
	On-line grab samples					
	Core spacing					
200–1000M	Line spacing					
	On-line grab samples					
	Core spacing					
Over 1000M	Line spacing					
	On-line grab samples					
	Core spacing					

* (Framework study means multi-purpose background data, not project specific information.)

SEA BOTTOM CHARACTERIZATION TO MAXIMUM 75M DEPTH

7. Indicate the adequacy of sample acquisition methods for regional framework studies if accompanied by high resolution acoustic/seismic profiles (Mark X). Indicate if response is location dependent (Yes, No) and why.

	Preferred	Useful	Little value	Location dependent (discuss)
Surface grab samples				
Soft sediment drop/Piston cores				
Percussion/Rotary drilled samples				
Rotary drilled cores				

8. For regional framework studies only: Are high quality, high resolution shallow penetration (0 to 500m) acoustic/seismic subbottom profiles an essential component of mapping, data integration and interpretation that should accompany a bottom sampling program? (Mark X)

Essential	Useful	Not needed	Site—specific locations only (discuss)

9. Identify and rank the sample characterization attributes of value to your objectives. (Mark X)

Sample attribute	Essential	Useful	Background	No interest	Comment
Lithology					
Mineral concentration					
Organic content					
Sediment texture					
Sedimentary structure					
Cementation/induration					
Porosity					
Permeability					
Acoustic properties					
Consolidation properties					
Paleontology					
Radiation					
Toxicity					
Living infauna					

10. What sectors of the EEZ are of interest for regional framework bottom sampling? Rank geographic areas of interest.
Mark High (H) Low (L) No Interest (NI)

State/Territory	Water Depth Range of Interest				Site-specific locations only
	Under 50M	50–200M	200–1000M	Over 1000M	
PACIFIC REGION					
Hawaii					
Alaska North					
West					
South					
Washington					
Oregon					
California North					
South					
Pacific Territories					
GULF-CARIBBEAN REGION					
Texas					
Louisiana					
Mississippi					
Alabama					
Florida West					
P. R. & V. IS.					

10. (continued)

State/Territory	Water Depth Range of Interest				Site-specific locations only
	Under 50M	50–200M	200–1000M	Over 1000M	
NORTH ATLANTIC REGION					
Maine					
New Hampshire					
Massachusetts					
Rhode Island					
Connecticut					
New York					
New Jersey					
SOUTH ATLANTIC REGION					
Delaware					
Maryland					
Virginia					
North Carolina					
South carolina					
Georgia					
Florida East					

11. What form of information products are most useful to you? (Rank 1,2,3...)
What is the preferred data format and data type? Respond for each kind of information needed.

Type of Information	Maps		Field or Processed Data		Seabed samples		Interpreted cross-sections	Integrated research reports
	Charts	Digital databases	Hard copy records	Digital database	Sub sample materials	Digital database		

12. What areas of research are of greatest inportance to potential development of the proposed use (by business or public agency)?

	Rank	Comment
Environmental impact		
Understanding geologic processes		
Tool development for data acquisition		
Resource recovery tools & methods		
Data base development		
Other		
None needed		

ANALYSIS OF RESPONSES TO QUESTIONNAIRE

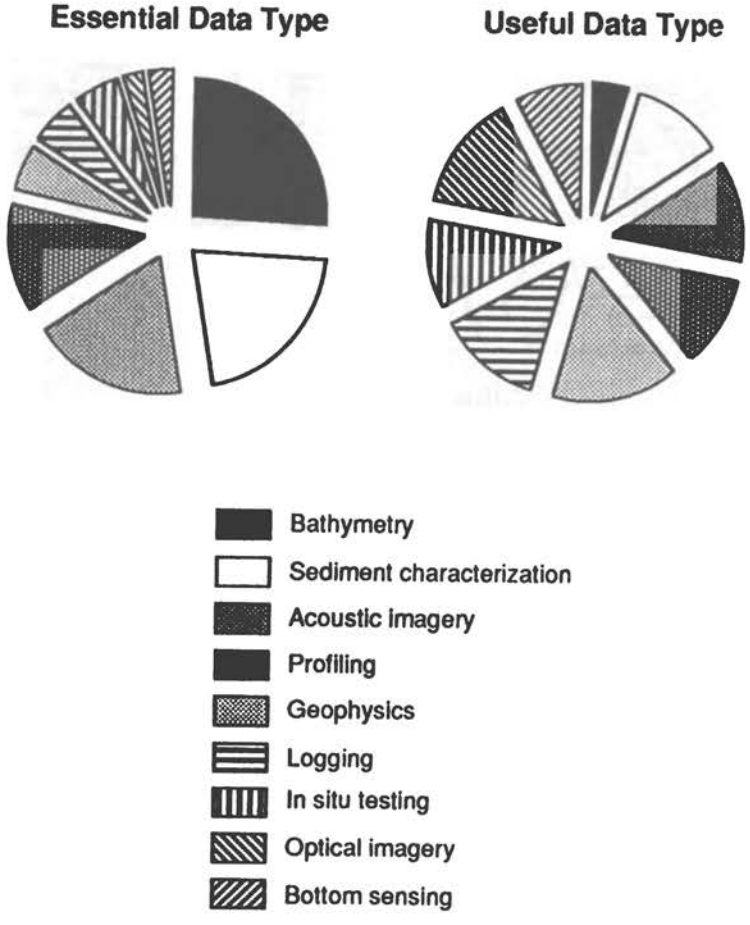


FIGURE E-1 Data Types: Responses by industry to preferred data types. Bathymetry and sediment characterization received the highest ranking as essential data types, with other data types considered useful.

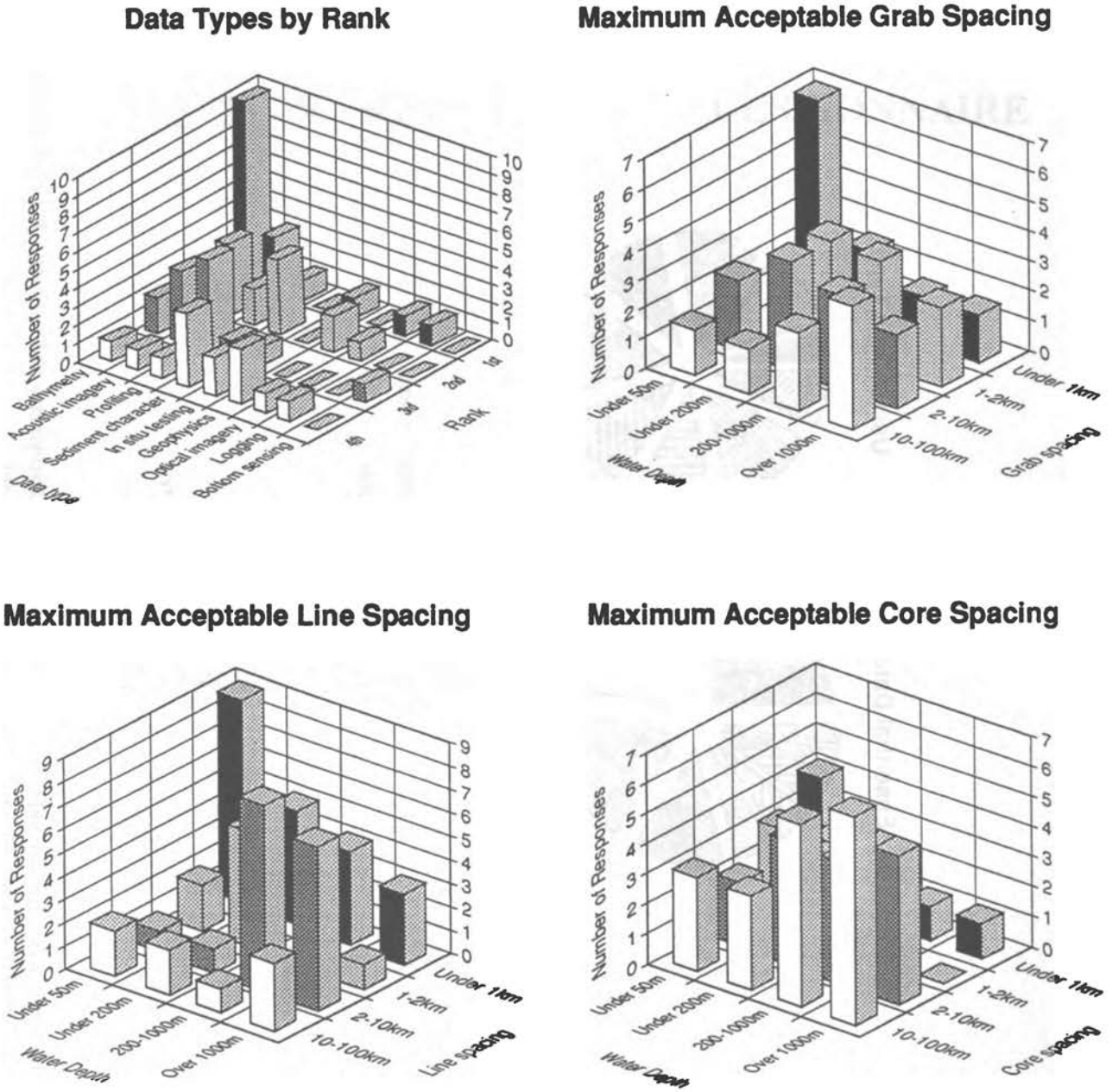


FIGURE E-2 Ranking of Data Types. Relative scaling of the industry responses to preference for data types and survey strategies. Upper left figure shows overwhelming rating of high-resolution swath bathymetry. The other diagrams show relationships of preferred data densities (right axis) to water depth. Peaks along the vertical diagonal indicate that as work depth decreases, the spacing between samples decreases and the number of necessary samples per unit area increases.

Are high resolution seismic profiles needed?

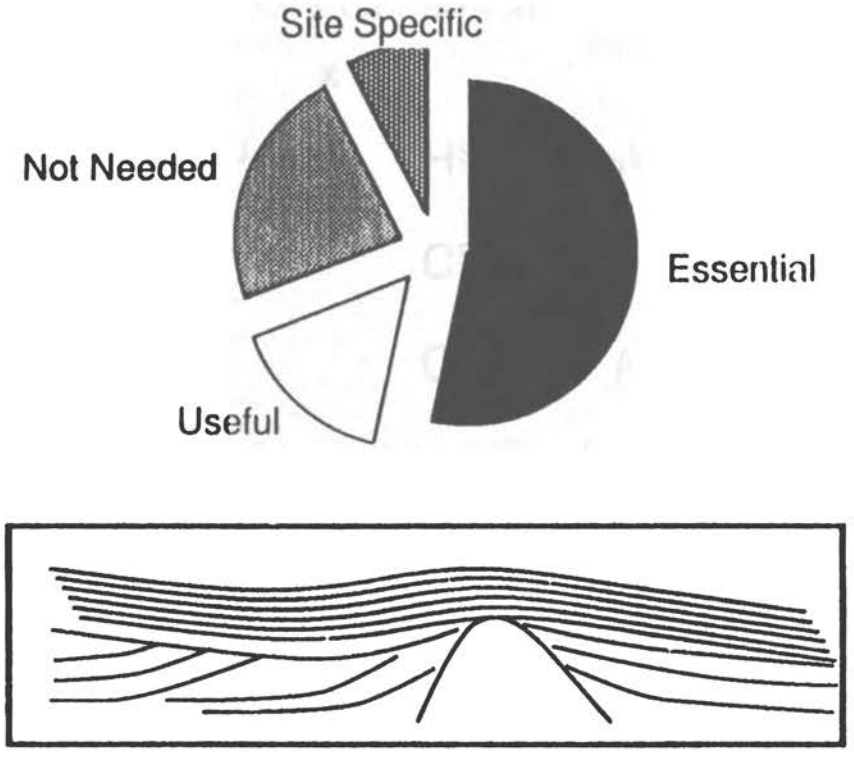


FIGURE E3

Sector of Interest within EEZ

Highest at all depths:	Oregon
Highest under 50m:	Oregon, Washington, Alaska, Florida
Highest 50-200m:	Oregon, Washington, California
Highest 200-1000m:	California, New York, New Jersey, Hawaii
Highest over 1000m	Hawaii, Pacific Territories

FIGURE E-4

What is area of research of greatest importance to potential development?

	Oil & Gas	Minerals	Cables, pipelines	Fisheries	Disposal
Geological processes	X				
Acquisition tool development		X			
Resource tool development			X		
Environmental impact				X	
Data base development					X

FIGURE E-5

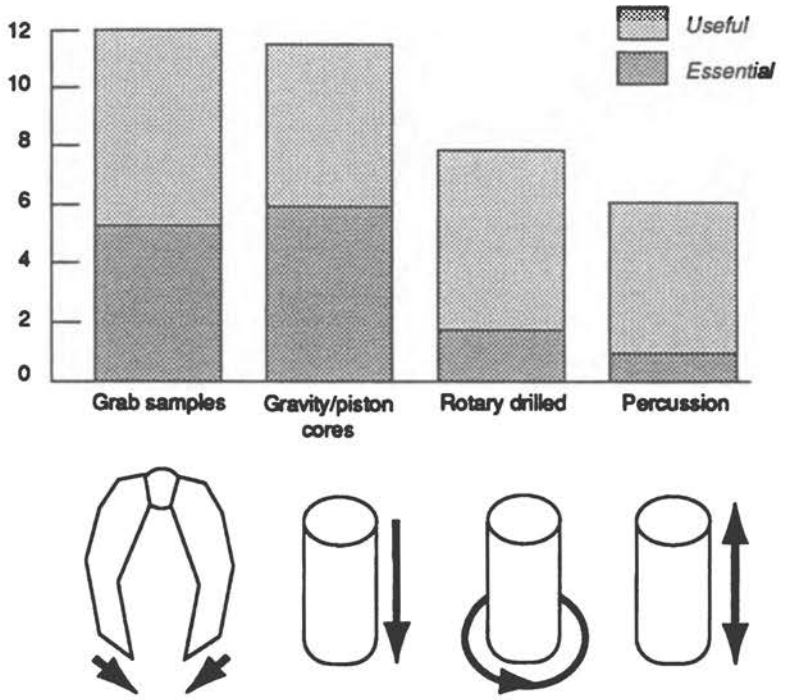


FIGURE E-6

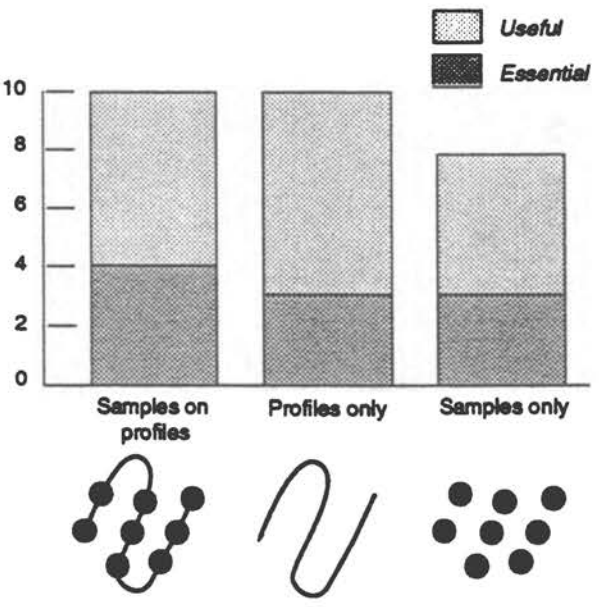


FIGURE E-7

APPENDIX F

OCEAN RESEARCH COMMUNITY

Ocean Research Community

In the final phase of investigation, the committee polled members of the ocean research community to ascertain priorities for regional framework and surveying information about the EEZ seabed. A questionnaire was mailed to nearly 150 scientists in research institutions. Certain trends clearly emerge that echo findings in the surveys of states' and industries' information needs.

FINDINGS

Data Types and User Needs

The interests of the research community were solicited by a questionnaire although some researchers are also represented in the states and industry groups.

The survey results are considered qualitative and probably do not represent a statistically valid sample. However, certain trends clearly exist. The research community expressed support for the following future program focus in priority order:

- understanding of basic processes
- systematic generation of maps and other products
- long range baseline studies or monitoring
- interaction of the water column with the bottom

The geographic interests expressed are somewhat confounded by the regions for the respective researchers and hence should not be used as a basis for prioritization. It should be pointed out that the research community does have an interest in shallow water as do the other groups.

The research community was consistent with other uses in showing a strong preference for bathymetry data over all other data types. The interests in other data types, however, does not decline so rapidly as with other user groups. The researchers expressed a much stronger interest in bottom sampling and only slightly less in acoustic imaging followed by high resolution reflection profiling. Interest in their data types gradually declined. The questionnaire and analysis of responses follow.

QUESTIONNAIRE

EXCLUSIVE ECONOMIC ZONE (EEZ) INFORMATION NEEDS SURVEY
RESEARCH COMMUNITY

Name _____

Title/Position _____

Organization _____

Address _____

City/State/Zip _____

Telephone/Fax _____

Please respond to the following questions by March 2, 1992

send to:

Ms. Susan Garbini
Marine Board, HA 250
National Research Council
2101 Constitution Avenue
Washington, DC 20418

1. What is your scientific field of interest that requires or utilizes seafloor data from the USGS/NOAA joint program for mapping and research in the EEZ?

_____

_____

2. In what part of the EEZ do you conduct your investigations (e.g., estuary, coast, inner shelf, outer shelf, slope, rise, islands, seamounts, reefs, atolls, etc.)

_____

_____

3. From what geographic areas of the U.S. do you need information from federal surveys (e.g., East Coast, Gulf Coast, West Coast, Alaska, Hawaii, island territories)?

1st priority _____

2nd priority _____

3rd priority _____

4. In what priority do you place the following types of data or information?

Measurement	Priority (1, 2,3....)
Bathmetry	
Acoustic imagery such as side-looking sonar	
High resolution sub-bottom reflection profiling	
Magnetic/gravity	
Heat flow	
Geochemical analysis	
Deep penetration reflection profiling	
Sediment characterization via remote sensing	
Bottom sampling	
Water column profiling and sampling	
Optical imaging, photography, and video	
Borehole testing, logging, in situ testing	
Time series information (in situ seafloor observations)	

5. What forms of information products are most useful to you? What is the preferred data format? Respond for each kind of information needed.

Type of Information	Maps		Field of Processed Data		Samples		Images
(In order of priority)	Charts	Digital Databases	Hard copy records	Digital databases	Sub-sample materials	Digital databases	

6. Do the necessary tools exist and is the current technology satisfactory to collect the type and quality of information you need in your area of interest?

Measurement	Tools Exist (Y or N)	Current Technology is Satisfactory (Y or N)
Bathymetry		
Acoustic imagery such as side-looking sonar		
High resolution sub-bottom reflection profiling		
Magnetic/gravity		
Heat flow		
Geochemical analysis		
Deep penetration reflection profiling		
Sediment characterization via remote sensing		
Bottom sampling		
Water column profiling and sampling		
Optical imaging, photography, and video		
Borehole testing, logging, in situ testing		
Time series information (in situ observations)		

7. How do you rank the need for an EEZ information and management system as the mechanism to provide the information?

Check one:

____ So high that with limited resources I would choose to have government agencies use available resources to place existing information in such a system rather than collect new information.

____ High enough to split resources 50-50 between collection of new information and management of new and old data.

____ Low

____ Not needed

8. If an information and management system is desired, the emphasis should be placed on managing and distributing [check appropriate response(s)]:

	Yes	No
Primarily digital databases	_____	_____
Combined analog archives and digital data	_____	_____
Primarily data from 1960 onward	_____	_____
Important to include earlier data	_____	_____
Only data whose quality is verified	_____	_____
All data regardless of verification	_____	_____
Primarily data collected by federal agencies	_____	_____
Data contributed by state agencies	_____	_____
Data contributed voluntarily by industry	_____	_____
Data contributed by academia	_____	_____

9. Should an EEZ data management system be a central repository or or regional repositories?	Central	Regional
Other: _____	_____	_____

10. Should it be operated by a federal agency or other groups?	Federal	Other
	_____	_____

Comment: _____

11. Rank in order of priority the focus you prefer for a future EEZ program.

	Rank (1, 2, 3)
A. Generation of specific survey products	_____
B. Understanding of basic processes	_____
C. Interaction of the water column with the bottom	_____
D. Long-range baseline studies or monitoring	_____
E. Other: _____	_____

12. **Would the federal program benefit from a non-governmental oversight body?**

Please Comment:

13. **Other Comments:**

ANALYSIS OF RESPONSES TO QUESTIONNAIRE

Scientific field of interest

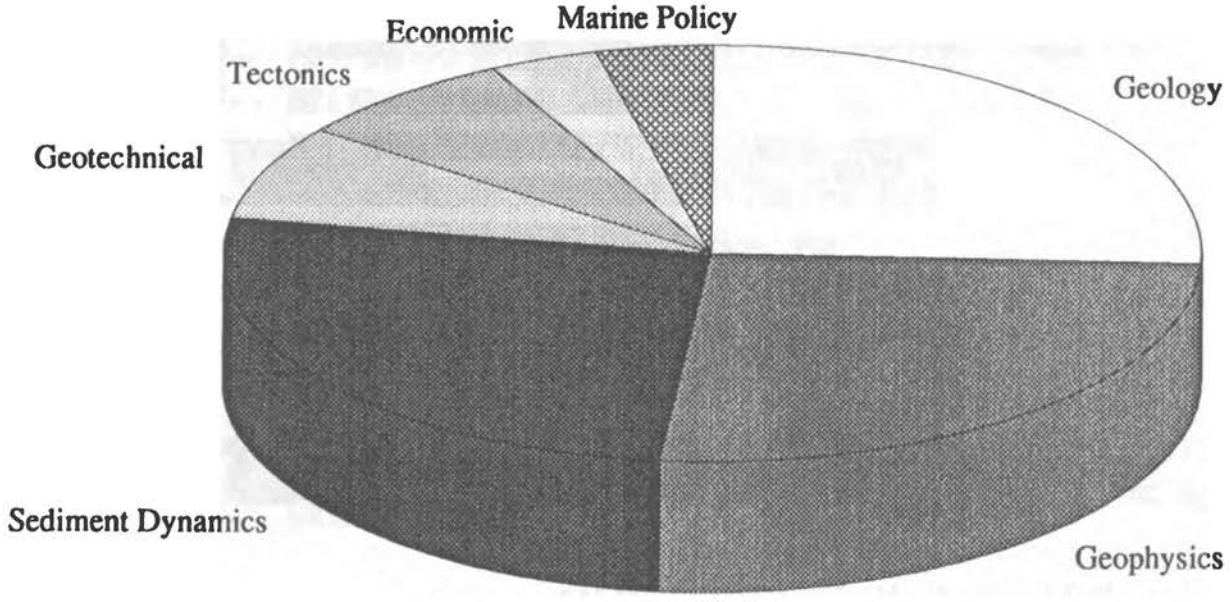


FIGURE F-1

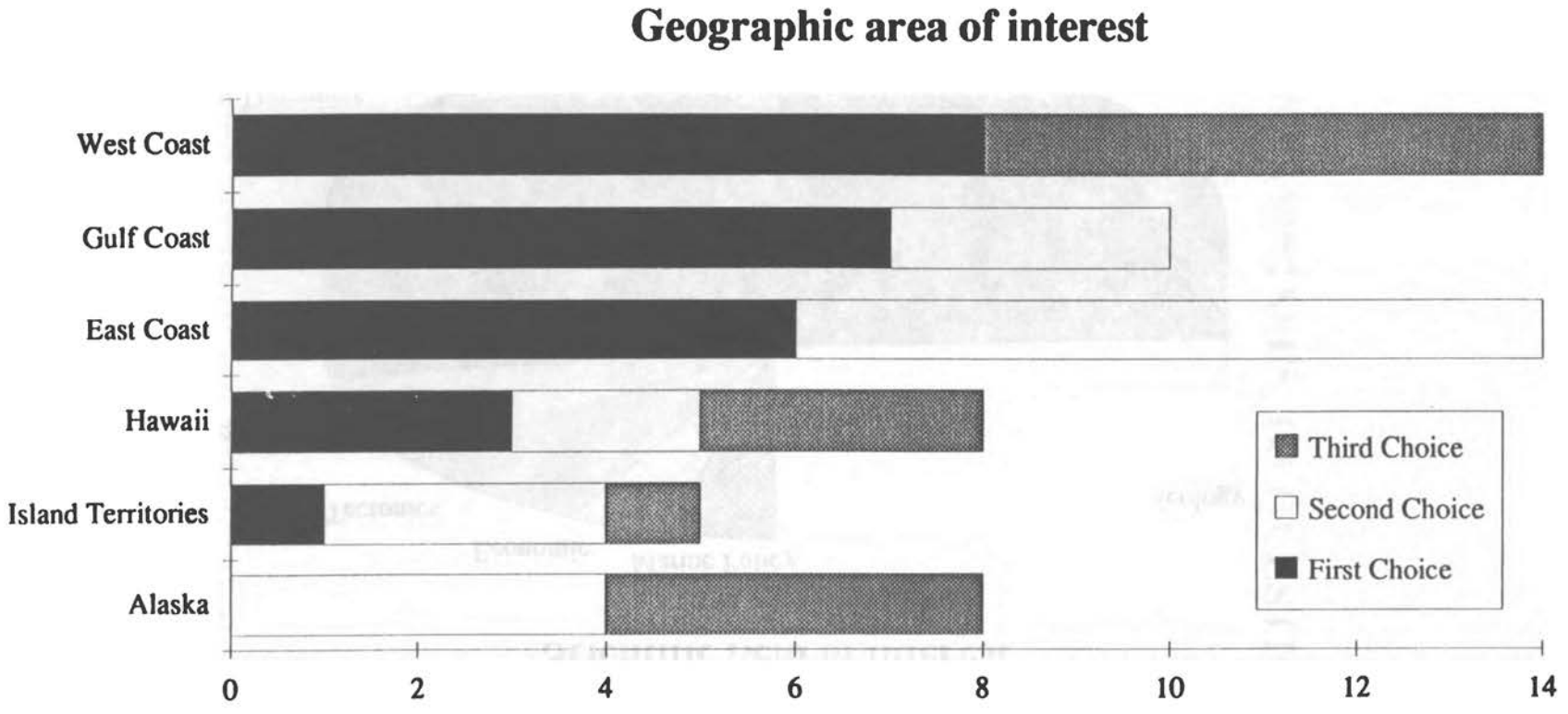

Geographic area of interest
West Coast
Gulf Coast
East Coast
Hawaii
Island Territories
Alaska
0
2
4
6
8
10
12
14
Third Choice
Second Choice
First Choice

FIGURE F-2

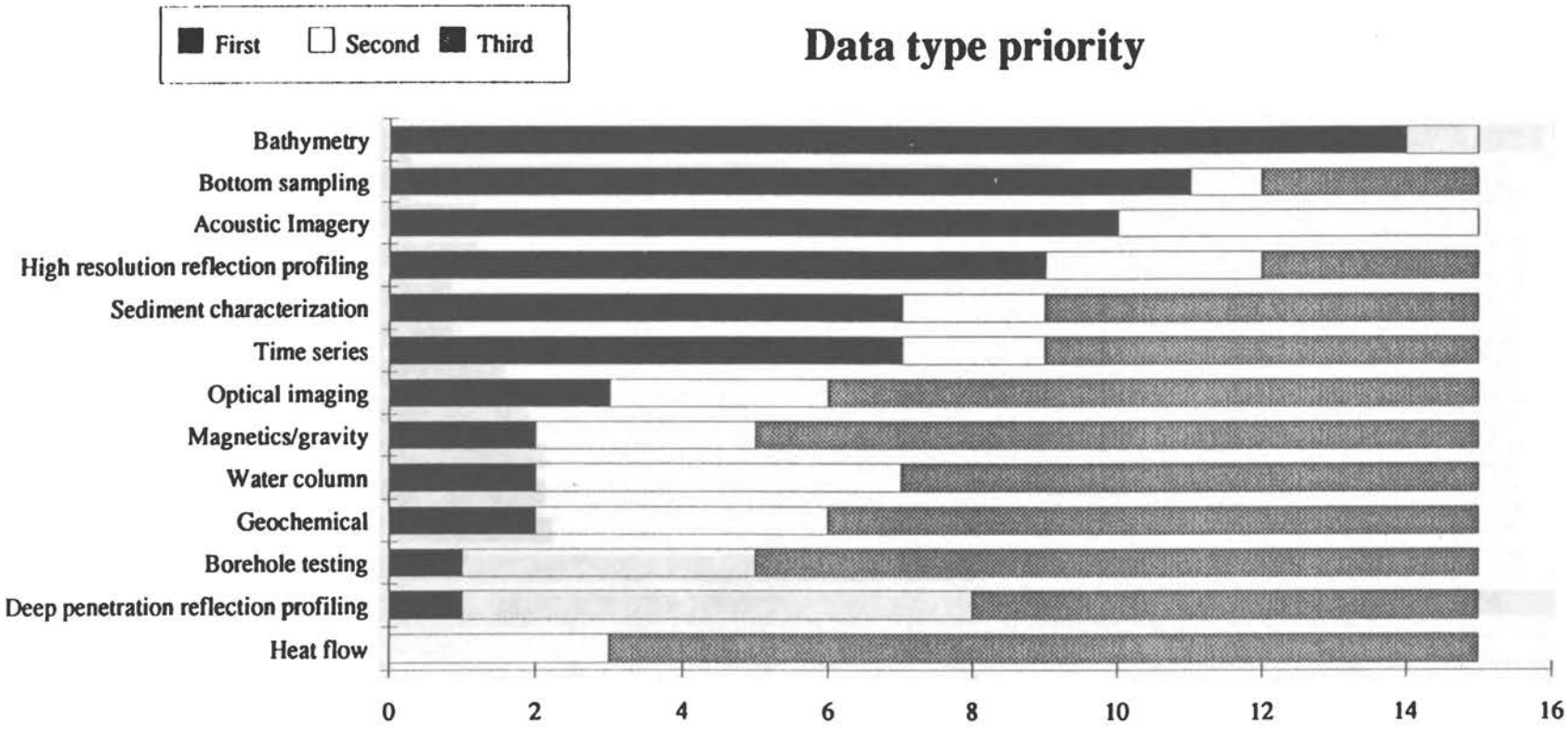

First
Second
Third
Data type priority
Bathymetry
Bottom sampling
Acoustic Imagery
High resolution reflection profiling
Sediment characterization
Time series
Optical imaging
Magnetics/gravity
Water column
Geochemical
Borehole testing
Deep penetration reflection profiling
Heat flow
0
2
4
6
8
10
12
14
16

FIGURE F-3

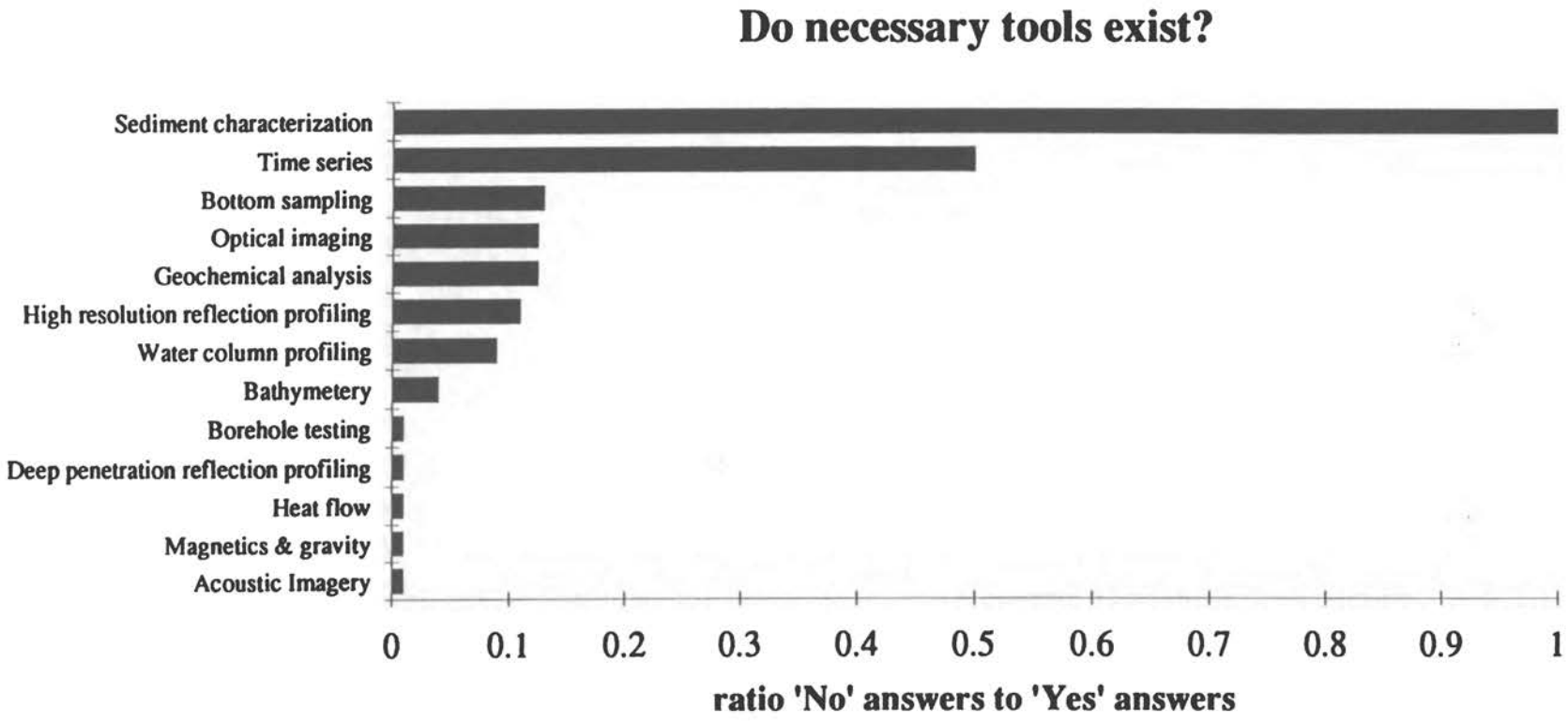

Do necessary tools exist?
Sediment characterization
Time series
Bottom sampling
Optical imaging
Geochemical analysis
High resolution reflection profiling
Water column profiling
Bathymetery
Borehole testing
Deep penetration reflection profiling
Heat flow
Magnetics & gravity
Acoustic Imagery
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
ratio 'No' answers to 'Yes' answers

FIGURE F-4

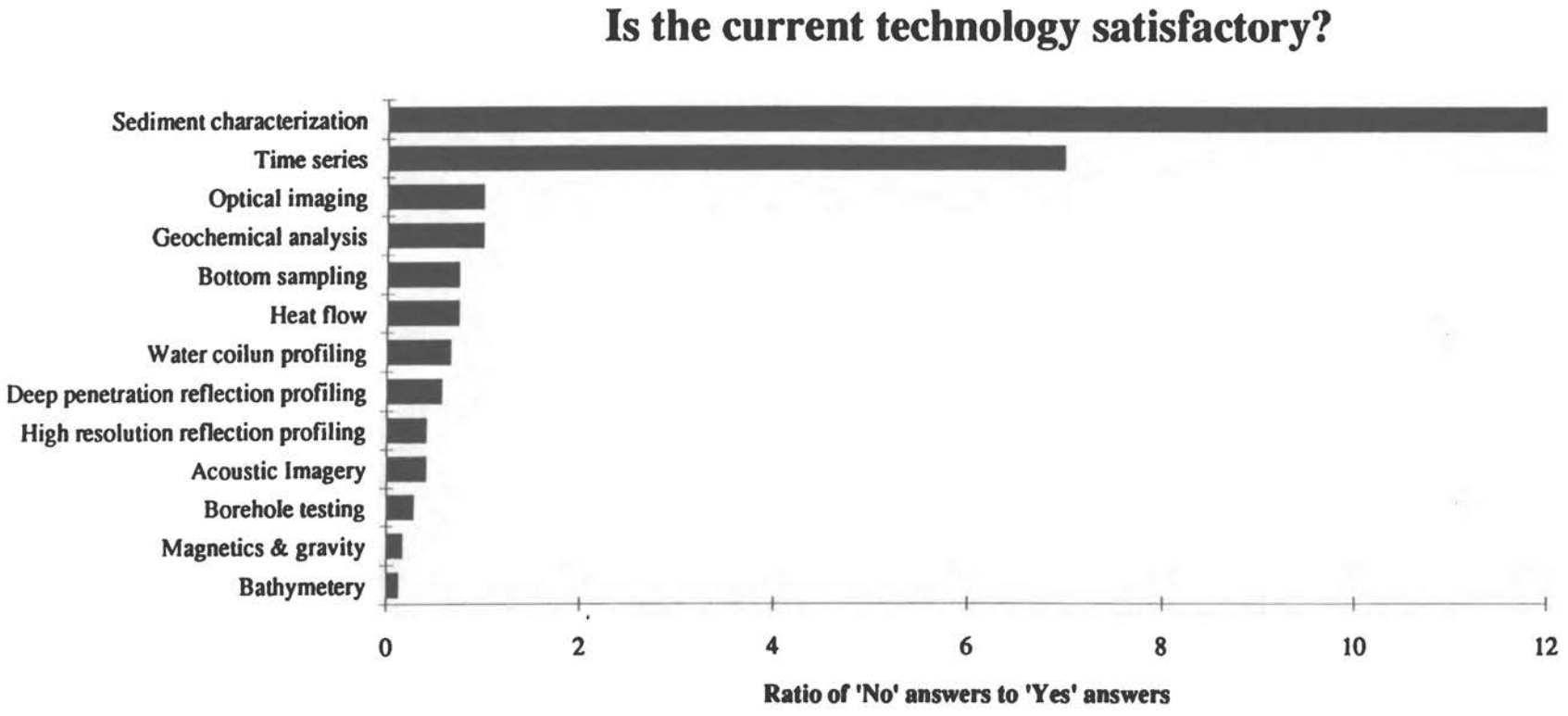

Is the current technology satisfactory?
Sediment characterization
Time series
Optical imaging
Geochemical analysis
Bottom sampling
Heat flow
Water coilun profiling
Deep penetration reflection profiling
High resolution reflection profiling
Acoustic Imagery
Borehole testing
Magnetics & gravity
Bathymetery
0
2
4
6
8
10
12
Ratio of 'No' answers to 'Yes' answers

FIGURE F-5

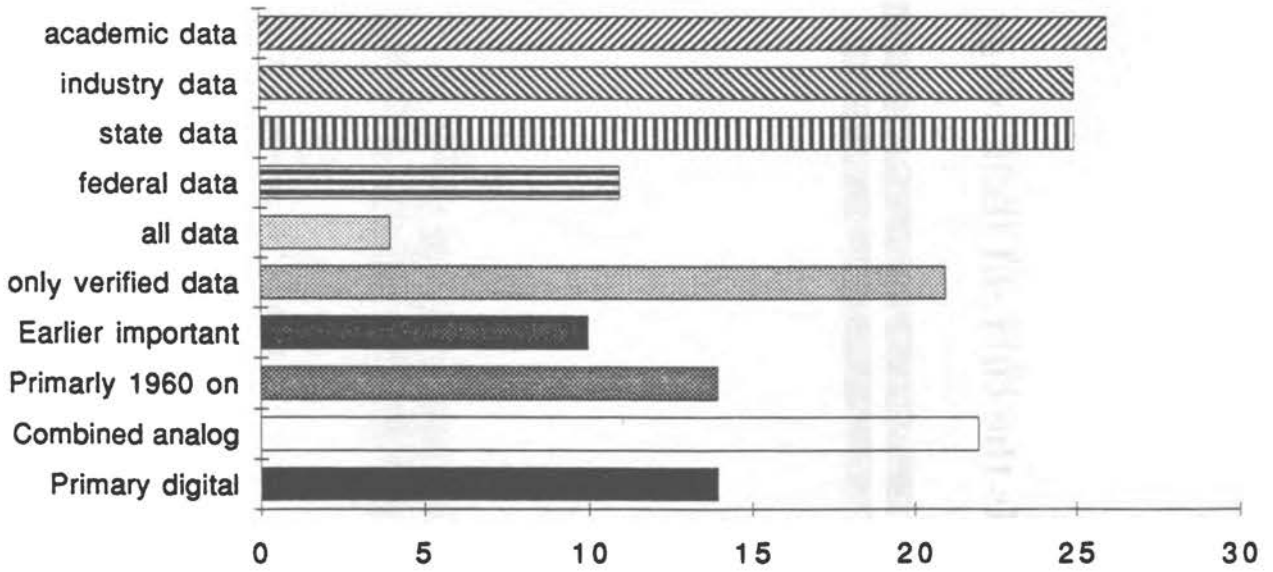

academic data
industry data
state data
federal data
all data
only verified data
Earlier important
Primarly 1960 on
Combined analog
Primary digital
0
5
10
15
20
25
30

FIGURE F-6

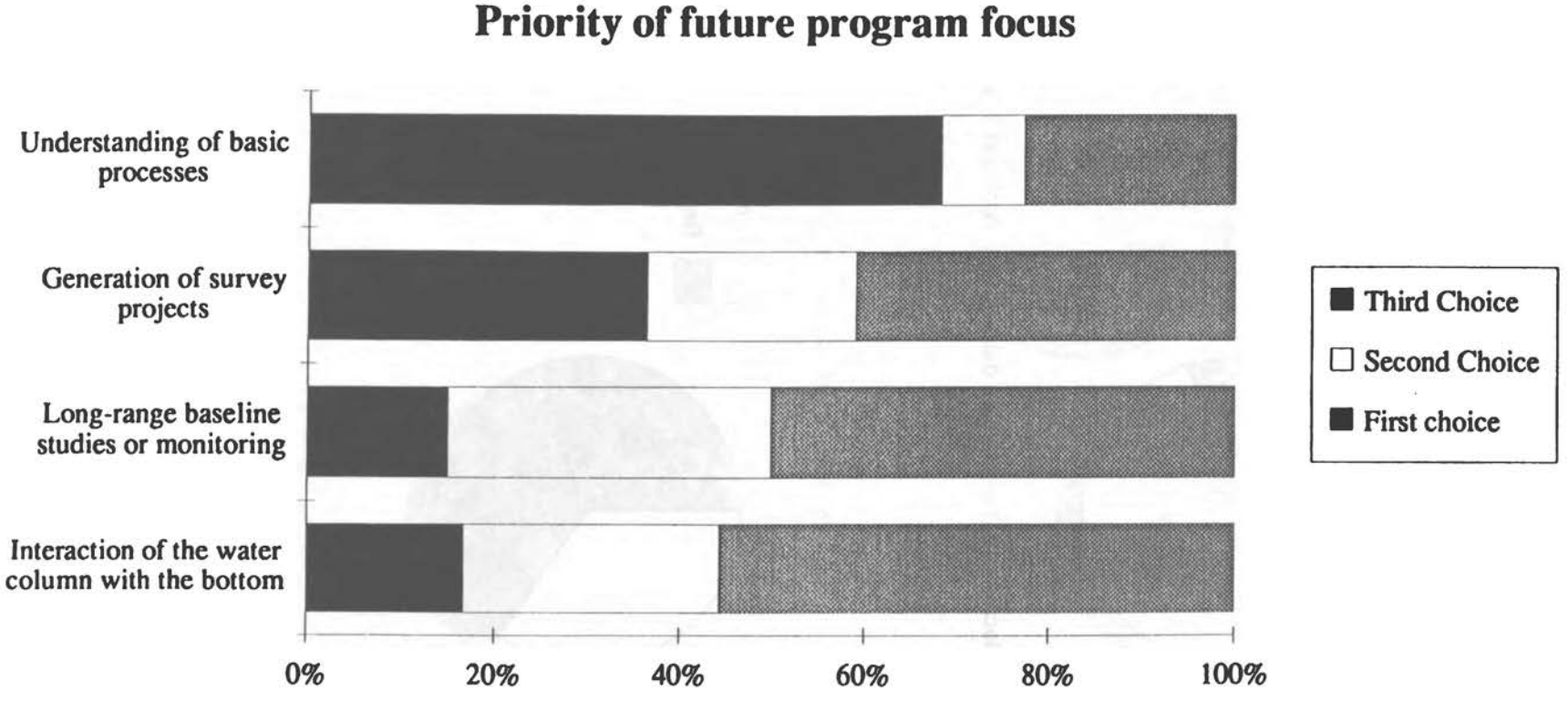
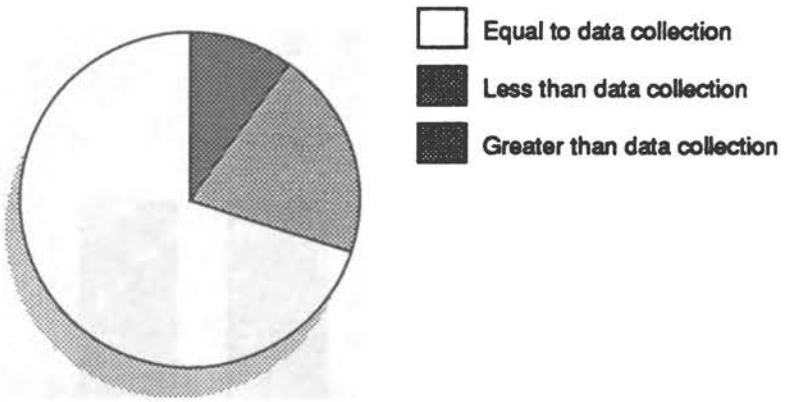
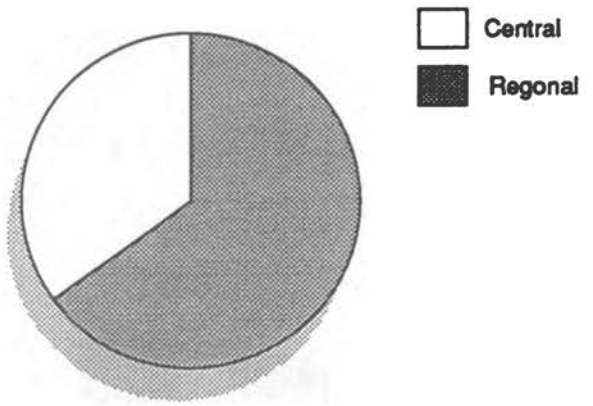

Priority of future program focus
Understanding of basic processes
Generation of survey projects
Long-range baseline studies or monitoring
Interaction of the water column with the bottom
0%
20%
40%
60%
80%
100%
Third Choice
Second Choice
First choice

FIGURE F-7



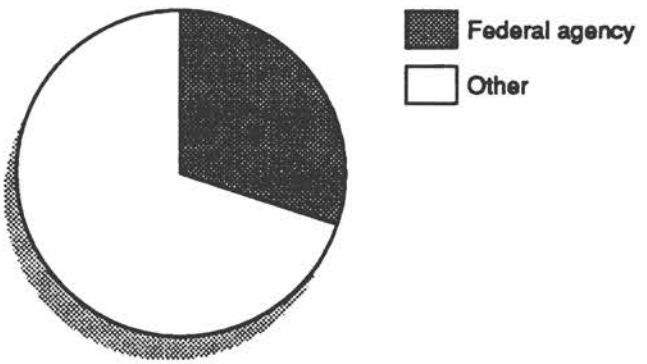
Allocation of resources for data management and information.

FIGURE F-8



Type of data responsitory.

FIGURE F-9



Who should operate a data management system?

FIGURE F-10

APPENDIX G

DATA MANAGEMENT WORKSHOP

USGS/NOAA EEZ SYMPOSIUM

November 5-7, 1991, Portland, Oregon

Data Management Issues

The theme of data and information management needs emerged again and again as a major area of concern to all users. In both the interim reports, the committee devoted considerable attention to these issues and tackled it directly by convening a workshop on "Data Management Needs" at the 1991 USGS/NOAA EEZ Symposium. A questionnaire was used to elicit the views of the attendees at the symposium, many of whom participated in the workshop. A summary of the findings, the questionnaire, and analysis of responses follow.

FINDINGS FROM THE DATA MANAGEMENT WORKSHOP 1991 EEZ SYMPOSIUM NOVEMBER 5-7, 1991

The Workshop:

The National Research Council Committee of Exclusive Economic Zone Information Needs held a half-day workshop on data management as part of the 1991 EEZ Symposium held in Portland, Oregon, November 5-7. An invitation mailed to all the participants, as well as the Workshop Description included with the Symposium program (see appendix) detailed a number of topics for open discussion regarding data acquisition, data processing, data integration, data access and archives which were felt important by the committee since they effect the design and development of an EEZ data and information system.

A number of questions for consideration were raised in the workshop description, as well as in a questionnaire distributed to all participants at the beginning of the Symposium (see appendix), and collected the day before the workshop. At the workshop the results of the questionnaire were discussed first in general session, followed by more detailed discussions in separate sessions:

Session A: Standards, Archives and Access, Leader: R. Chase

Session B: Processing and Integration of Data, Leader: R. Tyce

A final general session was held to review the specific finding of the separate sessions.

The Participants

The workshop attracted a large percentage of the symposium attendees, particularly considering it was the last event of the symposium, held the morning after the completion of all other activities. A complete list of the 40 participants broken down into sessions A and B is included in the appendix, with government employees representing the majority of the participants.

Analysis of Responses to the Questionnaire

The questionnaire distributed at the symposium was answered by only a few more participants than attended the workshop. The affiliations of the participants completing the questionnaire are tabulated below:

Private Sector	9
Academic	6
Government	25
Unknown	4
TOTAL	44

The questionnaire responses are provided in detail in Table 1. The first question dealt with policy questions concerning mechanisms for encouraging the exchange or sharing of data in the EEZ by public and private sectors. Most of the responses dealt with increasing the ease, awareness, and speed of availability of data, along with measures promoting private sector contributions to common public data bases. The second question dealt with the desirability of proprietary rights, with responses ranging from no limits on access to 8 year proprietary holds. Many respondents recognized the continuing need for proprietary rights to private sector data and for well defined delays in access to academic data only, as well as incentives for contributing private sector data in order to maximize public availability of data.

Questions 3-12 were divided into Standards, Processing, Integration and Access questions. On the question about standards, there was surprisingly strong agreement that the government should impose or at least establish standard data formats for data to be placed in EEZ archives, as well as on instrumentation and data collection procedures, though less so on the later. This sentiment was particularly strong for Federal and academic data, as well as for federal data acquisition, but was mixed for

industry data, and opposed for industry data collection. Participants felt that the archives should work to include non-standard data.

With regard to processing questions, the responses were strongly against the government providing only preprocessed data subsets, but mixed concerning government use of only community approved processing algorithms.

Regarding data integration, the responses were strongly in favor of the government integrating vector and raster into a common GIS format, and providing other than only individual, unbundled data sets.

Access questions received almost unanimous support for online electronic queries of data archives and opposition to distribution of only analog representations (maps and charts) of data. Most respondents considered response time critical, and dedicated (and thus distributed), specific archive and control facilities for one instrument or geographic area an advantage.

Summary of Workshop Discussions

Standards:

Workshop participants strongly supported a government role in establishing, adopting, and publishing standards for data collection procedures, for machine independent data formats and for quality assurance based upon data type and intended use. It was felt that the government should publish and use standard data structures that are GIS compatible. There was also strong sentiment that the system must be capable of including non-standard data. Continued exploitation of CD-ROM products with standard access and processing software was encouraged.

Processing:

Sentiment was strong that an emphasis on digital products was essential though not to the exclusion of analog products, and that this should include digitization of existing analog data. It was felt that both raw and processed data were needed in a timely fashion, with more complex evolutionary products following later.

The government was viewed as an important source of algorithms, software, standard processing procedures and GIS systems for public use. User input to data processing procedures and integration was viewed as an important part of defining database products.

Integration:

The workshop felt that the government should provide integration of individual data sets into GIS compatible products, utilizing standards established and published by the government, and that both individual and integrated data sets, along with integration software, should be made available together with attributes documenting the pedigree and quality of the data from collection through processing and integration. A need was expressed for the government to promote collaboration amongst all sectors regarding data collection, processing, integration and access.

Access:

Access to EEZ data was a major concern to workshop participants, with a strong expression of the need for rapid, user friendly assessment of, as well as access to the data. "Dial 1-800-EEZ-DATA" became a symbol of the type of access deemed needed for easy inventory of data location and characteristics, with low speed computer modem, as well as a single initial point of contact being essential. This represents a user friendly data base of data bases, with the ability to point to government and nongovernment holdings of data (including proprietary data), with the ability to browse through data attributes or characteristics. This implies a government keeper of the master data base of databases needs to be established, with clear delineation of access points for data versus data archives. Optimization of access and archiving, including central and distributed archives as part of the EEZ data base, was deemed an important role for the government. It was felt that the government could go a long way in its promotion of awareness, availability and ease of access to EEZ data sets, making its data archive "user seductive."

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Summary:

Questionnaire and workshop respondents resoundingly endorsed the need for national data management of EEZ data. Improving the ease by which users can locate, access, and contribute existing and future data was considered essential. This includes a lead role for the government in establishing standards for data collection, processing, integration, access, and archiving; as well as in developing and supplying software and techniques for these aspects. The need for digital data, even derived from previous analog data was clear, along with its availability in forms from raw through processed integrated forms as rapidly as possible was articulated. Linking and coordination of distributed data centers with accommodation of non-standard data was deemed important.

QUESTIONNAIRE

DATA MANAGEMENT ISSUES QUESTIONNAIRE

NAME (optional): _____

AFFILIATION: _____

Are you planning to attend the Data Management Workshop (Thursday morning 9:00 am - 12 noon)? Yes ____ No ____

As part of an ongoing project to advise the USGS and NOAA on their joint program for mapping and research in the Exclusive Economic Zone, the National Research Council Committee on EEZ Information Needs is seeking input from the oceanographic community on several topics that affect the design and development of an ocean data and information system. Your responses will be used to formulate recommendations on this topic. **PLEASE RETURN THIS QUESTIONNAIRE TO THE REGISTRATION DESK BY NOON WEDNESDAY, NOVEMBER 6.**

Policy Questions

1. What mechanisms should be used to encourage the exchange or sharing of data acquired in the EEZ by public and private sector users?

2. To what extent is the concept of proprietary rights to data desirable (i.e., for research studies or private sector use)?

Standards

3. The federal government should impose standard data formats for all data that will be placed in EEZ archives, including shared data.

Strongly agree _____
Agree _____
Disagree _____
Strongly disagree _____
No opinion _____

Federal data Yes ____ No ____
Academic data Yes ____ No ____
Industry data Yes ____ No ____

4. The federal government should impose standards on instrumentation and on data collection procedures for all data acquired in the EEZ and destined for EEZ data archives.

Strongly agree _____
Agree _____
Disagree _____
Strongly disagree _____
No opinion _____

Federal data Yes ____ No ____
Academic data Yes ____ No ____
Industry data Yes ____ No ____

Processing

5. The federal government should plan to preprocess various EEZ data sets and provide only preprocessed data subsets to users.

Strongly agree _____
Agree _____
Disagree _____
Strongly disagree _____
No opinion _____

6. In preprocessing EEZ data, the federal government should use only algorithms that have been preselected by an as yet undefined advisory group.

Strongly agree _____
Agree _____
Disagree _____
Strongly disagree _____
No opinion _____

Integration

7. The government should integrate vector and raster data and provide these data in a common GIS format.

Strongly agree _____
Agree _____
Disagree _____
Strongly disagree _____
No opinion _____

8. The government should plan to provide users with only individual, unbundled data sets.

Strongly agree _____
Agree _____
Disagree _____
Strongly disagree _____
No opinion _____

Access

9. The EEZ data archives should provide user queries via on-line electronic access.

Strongly agree _____
Agree _____
Disagree _____
Strongly disagree _____
No opinion _____

10. It will be sufficient for the government to plan on distributing only analog representations (i.e., maps and charts) of the data acquired in the EEZ.

Strongly agree _____
Agree _____
Disagree _____
Strongly disagree _____
No opinion _____

11. For your uses of EEZ data, is response time (i.e., the lapsed time from order to receipt of data) a critical issue?

Very critical _____
Critical _____
Not critical _____
No opinion _____

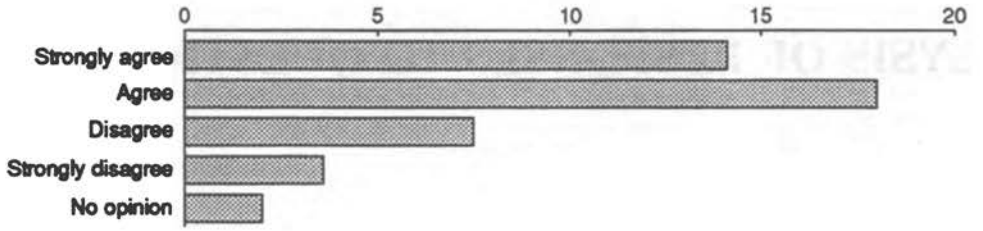
12. From your perspective, are there advantages to having dedicated archival and quality control facilities serving one type of instrument or a specific geographic region?

Many advantages _____
Some advantages _____
No advantages _____
Disadvantages _____
No opinion _____

••••••••••••••••

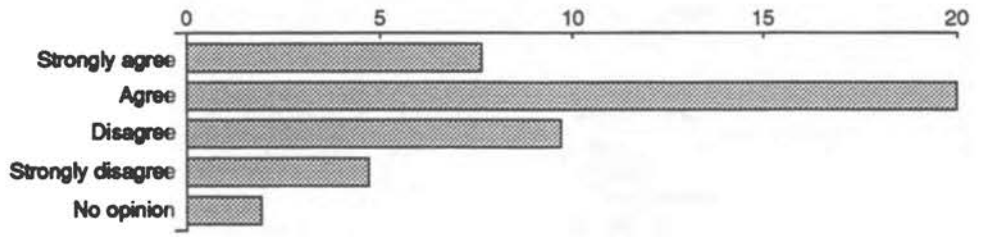
PLEASE RETURN THE COMPLETED QUESTIONNAIRE TO THE REGISTRATION DESK BY NOON, WEDNESDAY

ANALYSIS OF RESPONSES TO QUESTIONNAIRE



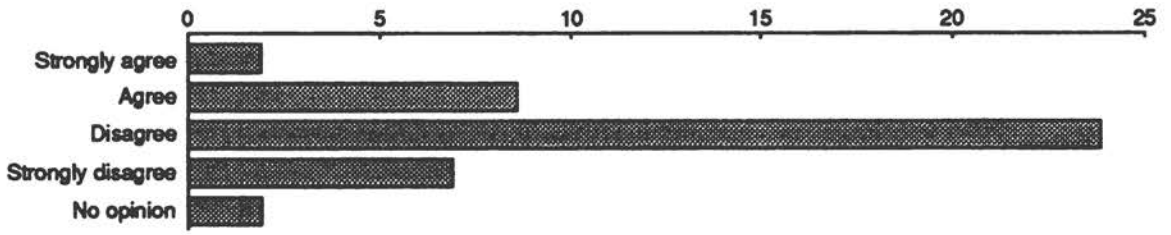
The federal government should impose standard data formats for all data that will be placed in EEZ archives.

FIGURE G-1



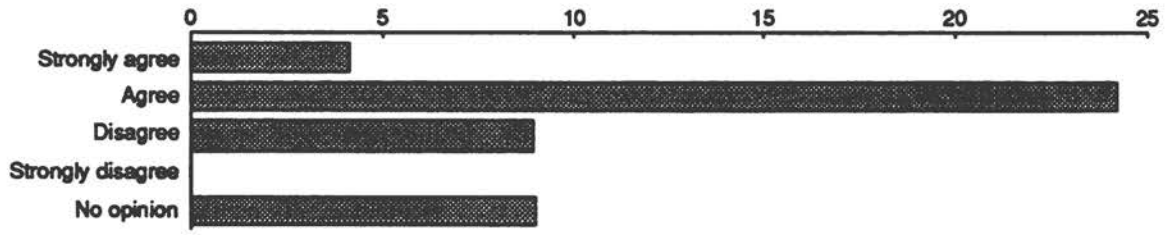
The federal government should impose standards on instrumentation and on data collection for all data acquired in the EEZ.

FIGURE G-2



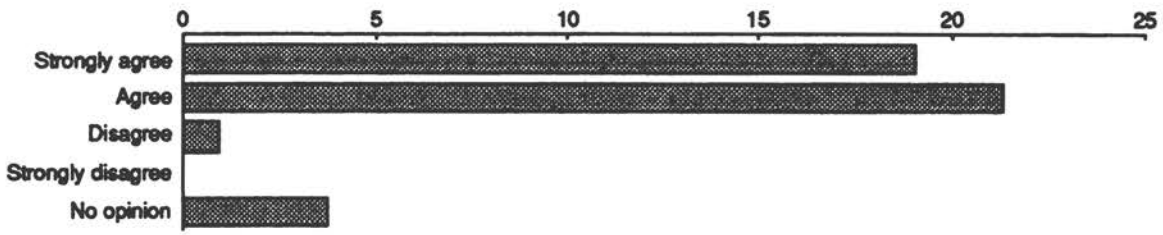
The federal government should plan to preprocess various EEZ data sets and provide only preprocessed data subsets to users.

FIGURE G-3



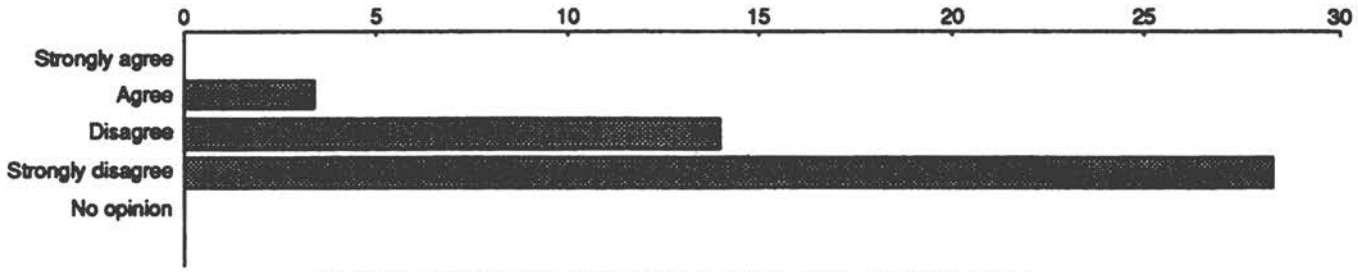
The government should integrate raster and vector data and provide these data in a common GIS format.

FIGURE G-4



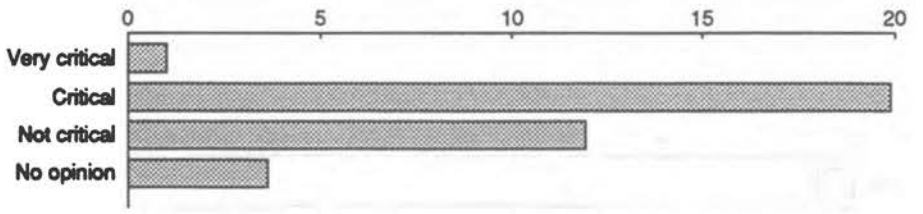
The EEZ data archives should provide user queries via on-line electronic access.

FIGURE G-5



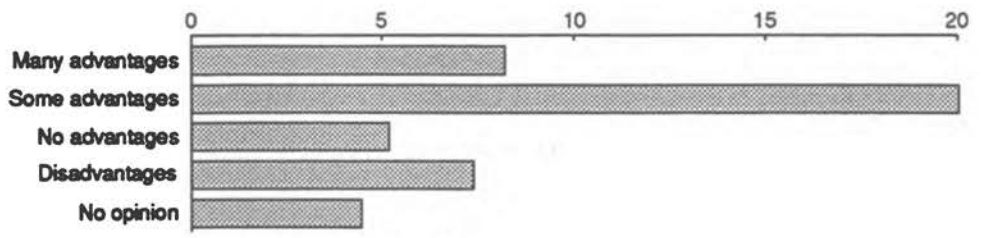
It will be sufficient for the government to plan on distributing only analog representations of data acquired in the EEZ.

FIGURE G-6



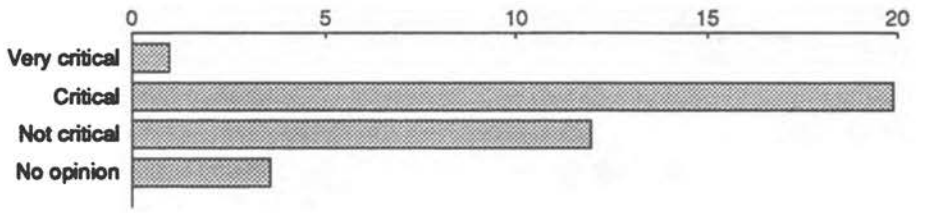
For your uses of EEZ data, is response time a critical issue?

FIGURE G-7



From your perspective, are there advantages to having dedicated archival and quality control facilites serving one type of instrument or a specific geographic region?

FIGURE G-8



For your uses of EEZ data, is response time a critical issue?

FIGURE G-9