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Interim Report of the Committee on Exclusive Economic Zone Information Needs

Coastal States and Territories

**Marine Board
Commission on Engineering and Technical Systems
National Research Council**

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**National Academy Press
Washington, D.C.
1990**

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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:

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PREFACE

This report is the first in a planned series by the Marine Board Committee on Exclusive Economic Zone (EEZ) Information Needs. The committee's charge is to provide advice to the U.S. Geological Survey (USGS) and National Oceanic and Atmospheric Administration (NOAA) Joint Office for Mapping and Research (JOMAR) in the EEZ on the needs of non-federal users of data and information from mapping and research activities.

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.

The committee is not, in this report, prepared to consider questions about allocation of resources for existing or future activities in the EEZ but has focused its efforts on determining the substantive (rather than quantitative) needs for various categories of data. Therefore, it takes no stand on whether ongoing programs, such as bathymetry or seafloor imagery, need to be modified.

This report is based on two courses of investigation linked by common aims: first, an analysis of responses to a questionnaire sent to the coastal states and territories asking them to prioritize their information needs in relation to present and planned uses of their offshore areas; and second, a determination of the data needs associated with specific present and potential EEZ uses or activities. The aims of this two-pronged approach are to encompass the core issues common to both the *users* and the *uses* of the EEZ.

Future reports will examine information needs of other segments of the user community, including industry and research organizations that have an interest in information about the nation's offshore areas, and will further explore the issues of technology needs and data management concerns associated with present and potential uses of the EEZ.

The committee's activities are sponsored by the USGS and NOAA.

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EXECUTIVE SUMMARY

A 1983 presidential proclamation created a 200-mile-wide belt of seabed jurisdiction adjacent to the United States and its island territories—the Exclusive Economic Zone (EEZ). The proclamation extends U.S. sovereign rights in this region for the purposes of exploring, utilizing, conserving, and managing natural resources. The U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA) conduct a coordinated program of mapping and research activities in the EEZ under their Joint Office for Mapping and Research (JOMAR). In addition to conducting mapping and research activities, JOMAR's objective is to provide leadership for the design, implementation, and coordination of a national program for appraisal of the EEZ and its non-living resources. At the request of the Director of the USGS and the Administrator of NOAA, the Marine Board established a committee representing the major non-federal users of seabed information to assist JOMAR in identifying the needs and priorities of the states, academia, and industry for data and mapping in the EEZ.

This report is the culmination of the first phase of the committee's activities and presents the results of two courses of investigation linked by common aims: first, an analysis of the needs of the coastal states and territories for information about the EEZ in relation to plans for future uses of offshore areas, based on a questionnaire sent to the U.S. coastal states and territories; and second, the results of the committee's independent research on the data needs associated with specific present and potential EEZ uses or activities. The aims of this two-pronged approach are to encompass the core issues common to both the *users* and *uses* of the EEZ.

The survey of the states and territories identified five principal concerns: management of biological resources, mineral resources, environmental assessment, shoreline management, and regionally focused interest in oil and gas development activities. Requirements for data related to pipelines, cables, ocean energy development, geohazards, cultural and recreational interests, and military uses were of much less general concern, although occasionally of regional importance. All respondents gave high priority to acquisition of seabed information for research.

Priority of data required varies with both type of use and stage of development. However, generalizing from the results of the survey, bathymetry and characterization of bottom sediments were the highest priority information desired. Seafloor imagery, high-resolution shallow penetration seismic profiles, and geophysical data (especially deep seismic profiles) follow in order of importance for the principal applications listed. Findings from the committee's independent research determined that bathymetry and sediment characterization were the highest priority data needs for seabed uses and activities, with shallow penetration profiling and seafloor imagery next in importance.

Because programs in bathymetry and seafloor imagery are currently being conducted by the USGS and NOAA, the committee concluded that the priority need for the next systematic wave of data gathering should be on bottom sediment characterization (including associated high-resolution shallow penetration profiling).

The committee also considered criteria for establishing priorities for the geographic focus of EEZ activities based on a balance between the states' interest in areas immediately offshore their most populated centers and the nation's interest in information about deepwater regions. This led to a conclusion that corridor swaths extending from the shoreline to the EEZ boundary are preferable to site-specific locales or coast-wise blocks.

Included in the committee's overall task is an evaluation of data management and dissemination aspects of EEZ activities. It was determined that 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. The committee concludes that this data system must be complete, ranging from data acquisition through and including distribution to end users in forms and formats suited to their needs.

Future reports will examine information needs of other segments of the non-federal user community, including industry and research organizations that have an interest in information about the nation's offshore areas, and continue to explore the common issues of technology needs and data management concerns associated with present and potential uses of the EEZ.

The findings and conclusions in this report are preliminary and subject to revision in future reports by this committee. Recommendations for action will be presented in a final report.

BACKGROUND OF STUDY

THE U.S. EXCLUSIVE ECONOMIC ZONE

A 1983 presidential proclamation created a 200-mile-wide belt of seabed jurisdiction adjacent to the United States and its island territories. This vast area, which more than doubles the nation's resource jurisdiction, is recognized as the Exclusive Economic Zone (EEZ). The proclamation extends U.S. sovereign rights in this region for the purposes of exploring, utilizing, conserving, and managing natural resources.

The EEZ contains both living resources, such as fisheries, and extensive and potentially valuable mineral and energy resources. The seafloor of the EEZ may also be suitable as a repository for wastes and is presently the site of cable communications and pipeline systems associated with transport of hydrocarbons.

Developing and using the resources of the seabed incur the responsibility of determining the most appropriate development and management policies for this vast area. The design of such policies should take into account both the economic importance of the resources and the environmental impacts of development activities. Prerequisites for the formulation of policies for the long-term management of this region in the nation's best interest are a comprehensive survey of the EEZ seabed and an understanding of its geologic, biologic, chemical and physical characteristics. This report represents the first phase of an effort to contribute to the improvement of ongoing federal activities to map and survey the EEZ as the first step in obtaining comprehensive scientific understanding of this region.

USGS/NOAA JOINT OFFICE FOR MAPPING AND RESEARCH

In 1984, the U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA) signed a Memorandum of Understanding to map the EEZ. In December 1987, their parent agencies, the Departments of the Interior and Commerce, signed a charter to coordinate mapping and research activities in the EEZ under the USGS/NOAA Joint Office for Mapping and Research (JOMAR). The charter stipulates that coordination with other federal, state, private, and academic organizations is necessary.

In addition to coordinating mapping and research activities, JOMAR's objective is to provide leadership for the design, implementation, and coordination of a national program to characterize the EEZ and its non-living resources. To achieve this goal, JOMAR is developing a long-term plan for mapping and research, based on the needs and priorities of all interested parties and the capabilities of available technology. 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. In addition, the drafts of JOMAR's "National

Plan for Mapping and Research in the Exclusive Economic Zone" and a proposal for "the first great survey of the American Ocean" (the American Ocean Program) have been circulated to federal agencies involved in ocean-related research and technology programs for comment and review.

NRC COMMITTEES

Following a series of exploratory discussions between the Office of Energy and Marine Geology of the 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 seafloor 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* (National Academy Press, Washington, D.C., 1989).

In May 1988, the Director of the USGS and the Administrator of NOAA requested that the Marine Board establish a new committee representing the major non-federal users of seabed information. They requested specific assistance with identifying the needs and priorities of the states, academia, and industry for data and mapping in the EEZ in order to provide JOMAR with an independent perspective on the information needs of potential seabed users. Following approval by the NRC's Governing Board, a committee was appointed in June 1989 to perform this task.

COMMITTEE COMPOSITION AND OBJECTIVES

Members of the committee on EEZ Information Needs were selected in consultation with the NRC's Ocean Studies Board. The membership includes 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. 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 non-federal 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.

This report is the culmination of the first phase of the committee's efforts to accomplish these objectives. It presents the needs of the coastal states and territories for information about the EEZ in relation to plans for future uses of offshore areas and the results of the committee's investigations of data needs in relation to specific uses or activities in the EEZ. Future reports will focus on acquiring responses from industry and academia about their information needs. Data management issues and technology needs will be considered in all phases of the committee's investigations where they are relevant.

To accomplish these objectives, the committee initiated investigations along two courses linked by common aims:

- first, determine regional needs for information through a questionnaire mailed to appropriate agencies in coastal states and territories to obtain a regionally representative sample of the nation's needs for information about its offshore areas in relation to planning for future uses; and

- second, determine the data needs related to specific EEZ uses or activities based on review of the relevant literature, discussions with researchers and experts, and the expertise and judgment of committee members.

This second line of investigation raised a number of questions related to data management that were intertwined with fulfilling the information needs associated with planned uses of the EEZ seabed. The question posed was: How can the information that is collected be made useful to potential users of the information in terms of data availability and effective distribution systems?

The findings and conclusions of this phase of the study represent a synthesis of analysis of the responses to the questionnaire by this segment of the *user* community and the perspective and expertise of the committee members based on independent research on information needs associated with specific *uses* and activities in the EEZ. Future investigations will be conducted in a similar manner—that is, along two courses. Another segment of the non-federal user community will be surveyed to determine their information needs (e.g., industry users). At the same time, the committee will continue its own research and produce a synthesis of data from surveys and from their own research and independent investigations in the form of findings and conclusions. A final report will bring together all the findings and conclusions of the project and produce recommendations for specific action.

The task of this project is not viewed as simply to present the results of surveys, but rather to combine parochial interests of various users with a broader perspective that takes into account the national interest in the ocean and its resources.

Because these reports are intended as advice to JOMAR in relation to ongoing mapping and research activities, 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.

The committee is not, in this report, prepared to consider questions about allocation of resources for existing or future activities in the EEZ but has focused its efforts on determining the substantive (rather than quantitative) needs for various categories of data. Therefore, it takes no stand on whether ongoing programs, such as bathymetry or seafloor imagery, need to be modified.

COASTAL STATES' AND TERRITORIES' NEEDS FOR SEABED INFORMATION

DESCRIPTION OF QUESTIONNAIRE

The Committee on Exclusive Economic Zone (EEZ) Information Needs sent a questionnaire on "EEZ Seabed Uses and Information Needs" to 72 offices in 23 coastal states and 5 U.S. territories (see Appendixes A and B), 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 potential 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 have been 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. Regions were defined in accordance with the NOAA State Coastal Zone Management Program, except that Alaska and the Pacific Islands are treated as separate regions. The regions are:

<i>North Atlantic:</i>	Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island
<i>South Atlantic:</i>	Delaware, Georgia, Maryland, North Carolina, South Carolina, Virginia
<i>Gulf/Islands:</i>	Alabama, Florida, Louisiana, Mississippi, Puerto Rico, Texas, Virgin Islands
<i>Pacific:</i>	California, Oregon, Washington
<i>Pacific Islands:</i>	Guam, Hawaii, Northern Marianas, American Samoa
<i>Alaska:</i>	Alaska

The structure of the questionnaire allowed incomplete, subjective, and impressionistic responses and therefore is not susceptible to rigorous statistical analysis. However, the responses indicate clear trends and the relative importance of uses and information needs. Additional information was provided by many respondents in cover letters and these were also reviewed by committee members.

ANALYSIS OF RESPONSES

Figures 1 through 6 present the information from the questionnaires in tabulated form (Figures 1, 2, and 4A-F) and then in bar graphs (Figures 3A-B and 5A-F). Figures 6A-B summarize information from the questions on page 2 of the questionnaire: "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?" and comments made in cover letters accompanying the returned questionnaires. Following is a description and explanation of each figure:

- Figure 1 shows a tabulation of all responses in all categories of use by information need. Almost all respondents ignored the distinction between reconnaissance and site-specific tasks. The left number indicates the number of "1" ratings ("essential"); the right number indicates the number of "2" ratings ("useful"). The "3" rating has been eliminated, because it seemed to cover a vague range of meanings from "background" to "useless."
- Figure 2 shows a weighted score in each box. This was obtained by doubling the number of "1" ratings and adding them to the number of "2" ratings. The score indicates the relative strength of response for each use/information category. The last column of the table is a "total score" for all information needs in each use category, and gives some indication of the relative importance the respondents place on each use category. The "total score" at the bottom of the table gives an indication of the relative importance the respondents place on each information need category.
- Figures 3A and 3B display the total scores for uses and information needs from Figure 2.
- Figures 4A-F show weighted responses for uses and information needs by region, with total scores for uses. Regions were defined in accordance with the NOAA State Coastal Zone Management Program, except that Alaska and the Pacific Islands are treated as separate regions for our purposes. A list of the states/territories in each region is given on the bottom of each figure, with the number of responses in parentheses.
- Figures 5A-F display the total scores for uses for each region from Figures 4A-F.
- Figures 6A and 6B summarize information from sources other than the table. These include responses to the question on page 2 of the questionnaire: "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?" and comments in cover letters. Similar responses by more than one agency in a state, or identification of more than one location within a state was counted only once in the bottom line totals of Figure 6A and in the regional subtotals Figure 6B. Figure 6B summarizes the responses by region designed to identify the level of common interest in a region as well as to highlight differences between regions.

The survey identified five principal concerns. All respondents specified concerns about management of biological resources, particularly fisheries; mineral resources, including placers, aggregates, and phosphates; environmental assessment, including placement and monitoring of waste; shoreline management; and strong but more regionally focused interest in oil and gas development activities.

Requirements for data related to pipelines, cables, ocean energy development, geohazards, cultural and recreational interests, and military uses were of much less general concern, although occasionally of regional importance.

All states gave high priority to acquisition of seabed information for research. No supporting explanation was provided for this category. It is presumed by the committee that this category includes needs identified in other use categories. Future investigations will seek better definition of this area, which was left open-ended and undefined in the questionnaire. Research is an essential foundation of every use of the ocean and its resources. A different approach will be necessary for determining the priorities for research needs. The states stressed the need for more information collected on the continental shelf, rather than information from the slope and deep ocean.

Generalizing from the lumped results (Figure 3B), bathymetry and distribution and characterization of the bottom sediments were the highest priority information desired. Seafloor

imagery, high-resolution seismic profiles and geophysical data, especially deep seismic profiles, follow in order of importance for the principal applications listed. An elaboration of these classes of seabed data follows:

- *Bathymetry*, in general, has more stringent requirements for horizontal and vertical resolution near shore, less stringent in greater water depths. Exceptions are where a high level of sea bottom activity extends into deep water, such as in the Gulf of Mexico, where pipelines and oil and gas production structures will soon be placed in water depths of 3,000 feet, 130 miles from shore.
- *Sediment characterization*, including chemical and physical properties as well as thickness and lateral extent, has particular significance for placer and aggregate mining, waste disposal, and oil and gas development, including pipeline placement. Along with bathymetry, sediment characterization by sampling and high-resolution seismic profiling are fundamental components of the EEZ seabed data base for which systematic data acquisition are needed. They provide the necessary ground truth calibration required to fully exploit the information contained in seafloor imagery.
- *Seafloor imagery*, with potential for concurrent generation of bathymetric data, is of high priority, especially in the interpretation of the dynamic processes leading to current seabed morphology, e.g., sediment slumping, active faults, tectonism, diapirism. Following completion of the deepwater GLORIA surveys (side-looking or side-scan sonars that provide acoustic images of the seafloor—Geologic Longrange Inclined ASDIC developed in the United Kingdom and currently used by the USGS in their EEZ mapping program), local and more detailed surveys would be required to serve the applications identified.
- *Deep seismic profiling* has direct applications for geohazard analysis in areas with active faulting and in the regional understanding of the structure and evolution of sedimentary basins. Its use is justifiable for regional tectonic framework analysis and on a project case-by-case basis where there are site-specific needs. It is not economically practical as a general high-density survey tool, unrelated to economic development activity and is therefore lower priority data in the context of general EEZ information needs.

INDEPENDENT ANALYSIS BY COMMITTEE

INFORMATION NEEDS BASED ON USES

The second course of investigation was to determine the data requirements related to specific EEZ uses or activities: oil and gas exploration and development, pipelines, hard minerals exploration and development, waste disposal (including monitoring), cables and military uses, cultural, biological resources (including monitoring), ocean energy, geohazard analysis, and shoreline management. Data requirements were keyed to the following data gathering activities: bathymetry, seafloor imagery, sediment characterization, near-surface profiling, geophysics, bottom sensing, optical imagery, in situ testing, and borehole logging.

In considering the usefulness of mapping and information gathering systems to potential EEZ uses, it is important to distinguish between data obtained through a wide variety of surveying and bottom mapping tools and techniques, at different scales and accuracies, including water depth (bathymetry), seafloor imagery (mostly acoustic, some photographic), subbottom profiling, and direct sampling of seafloor surface and subsurface sediment characteristics.

Surveying and mapping of seafloor characteristics provide fundamental and essential data and information for resource development and environmental protection at different scales and accuracies and for different purposes. Reconnaissance surveys provide a broad overview of regional geology, seafloor morphology, rock or sediment type and large-scale features. High-resolution mapping is required for task-specific or site-specific surveys.

Based on the committee's review of the relevant literature, discussions with researchers and other experts, and their own expertise and judgment, priorities for types of information required for seabed uses and activities were ascertained. Bathymetry and sediment characterization are determined to be the highest ranked data needs. The results of these investigations are summarized in Figures 7A and 7B.

- Figure 7A presents the ranking of data type requirements for various classes of EEZ applications, with 1 as the highest level of need and 5 as the lowest.
- Figure 7B displays this information in a bar graph, with "highest interest" representing data types, ranked most frequently as first or second choice for priority, and "strong interest" reflecting data types clearly useful for the identified applications listed in Figure 7A, but ranked to be of lesser priority.

Bathymetry: NOAA is conducting high-resolution mapping in the EEZ with a multibeam bathymetry system. Prioritization is necessary because it will take NOAA's present high-resolution bathymetry systems three to ten times longer to cover the areas mapped by GLORIA. Increasing the rate of coverage would require additional ships and acquisition of improved technology.

Reconnaissance survey: The USGS is conducting surveys of the EEZ using a reconnaissance-scale side-scan sonar (GLORIA), which is towed near the ocean surface at 10 knots with a swath width

of 60 km. Interpretation of much of the detail seen on GLORIA images will require sampling in order to calibrate the attributes that are observed. Documentation of both bottom and sub-bottom formations would be greatly aided by a systematic grid of shallow penetration, high-resolution acoustic profiles as a frame of reference for sampling locations and as a key tool in mapping and interpretation.

Seabed characterization: Accurate use-specific resource and site evaluations require ground truth information based on seafloor sediment samples. To date, seabed sampling activities have mainly been conducted as part of limited, special purpose or site-specific projects and as part of broader nearshore coastal studies. A coherent program of offshore sea bottom mapping extending into deep water is less well-defined. Sample recovery and characterization analyses are significantly more labor intensive and time consuming than the more automated digital data acquisition and processing that characterizes bathymetry, imagery, and acoustic profiles. The types of information that can be derived from a bottom sampling, coring, and profiling program are listed below.

<i>Sample attributes:</i>	Lithology
	Mineralogy
	Organic content
	Ore mineral concentration
	Grain size, shape, and hardness
	Sorting
	Bed thickness
	Sedimentary structure
	Sequency character
	Cementation
	Solubility
	Porosity
	Permeability
	Acoustic properties
	Paleontology
	Radiation
	Toxicity
<i>Profile character:</i>	Bed continuity and correlation
	Areal extent
	Layering geometries
	Stability indicators
<i>In situ testing:</i>	Compressibility
	Strength
	Fracture pressure
	Plasticity
	Density
	Permeability
	Velocity
	Temperature
	Conductivity

The next round of user requirements analysis will attempt to define which attributes are most frequently needed and to determine analytical and descriptive standards that will maximize usefulness to a maximum number of potential users.

DATA MANAGEMENT ARCHITECTURE FOR SEABED INFORMATION

A major objective of this assessment is 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 independent analysis of information needs in relation to specific uses of the EEZ raised a number of issues related to data management needs, giving rise to the question of how the information that is collected can be made useful to potential users in terms of data availability and effective distribution systems.

The committee's investigations into the information requirements associated with present and potential uses of the EEZ reveal that data management issues will become increasingly important and more difficult to deal with unless a complete systems perspective is adopted at the outset. More specifically, the data needs expressed by respondents to the committee's questionnaire suggest that analog, interpretive, map-based products are suboptimal—although necessary—products. Consequently, present practices in data processing, archiving, and dissemination should be carefully examined to ensure that both current and unforeseen future needs will be met in a timely and cost-effective manner.

By adopting a systems perspective at this time, the EEZ program will be the beneficiary of a total systems architecture that embraces full consideration of current sensor technology, state-of-the-art data interpretation, and computer system components. A total system perspective is best suited to accommodate uncertainties that lie ahead: changes in sensor systems, new computer products, evolving analytic techniques, and—perhaps most important of all—an uncrystallized but rapidly developing clientele for the resultant data products.

In essence then, a strategic user-oriented vision of the EEZ program must be developed. This vision will not only reflect the uncertainties of the user community—and therefore the need for flexibility—but also reflect the evolving character of technology needed to keep the EEZ program in the forefront of science and applications.

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.

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	48/7	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")

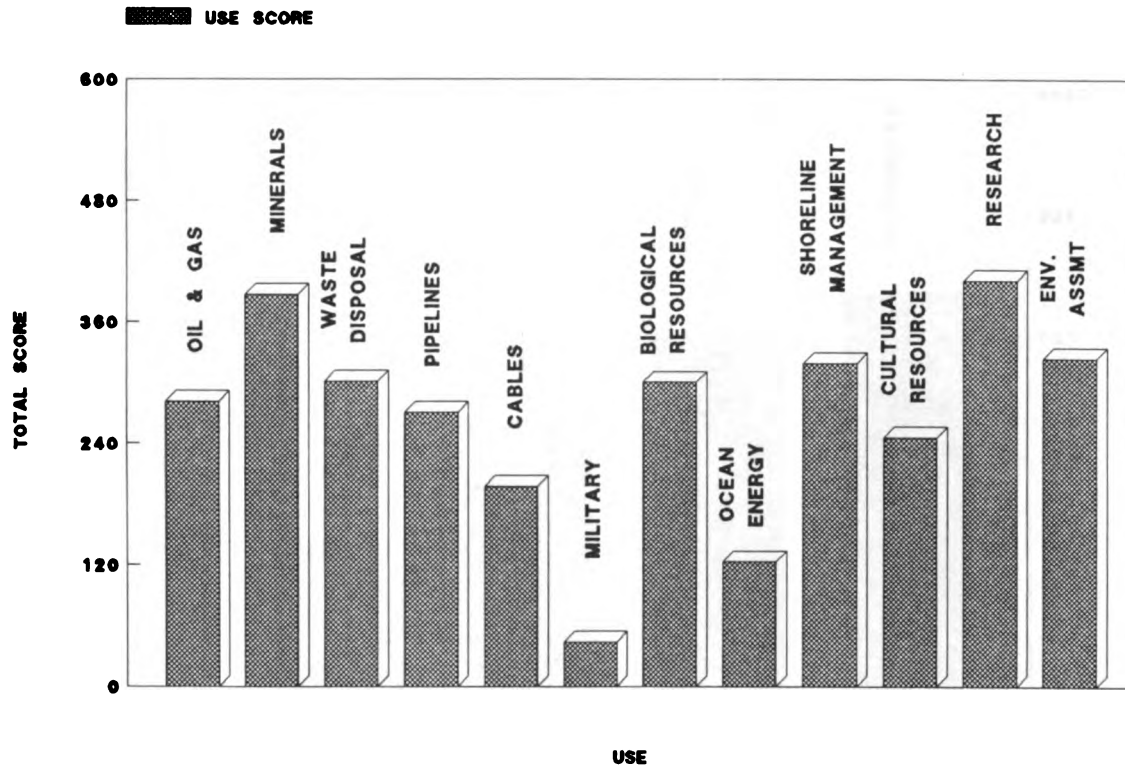
*Right number = 2 ("useful")

FIGURE 2: Weighted Responses and Totals*

EEZ SEABED USES AND INFORMATION NEEDS

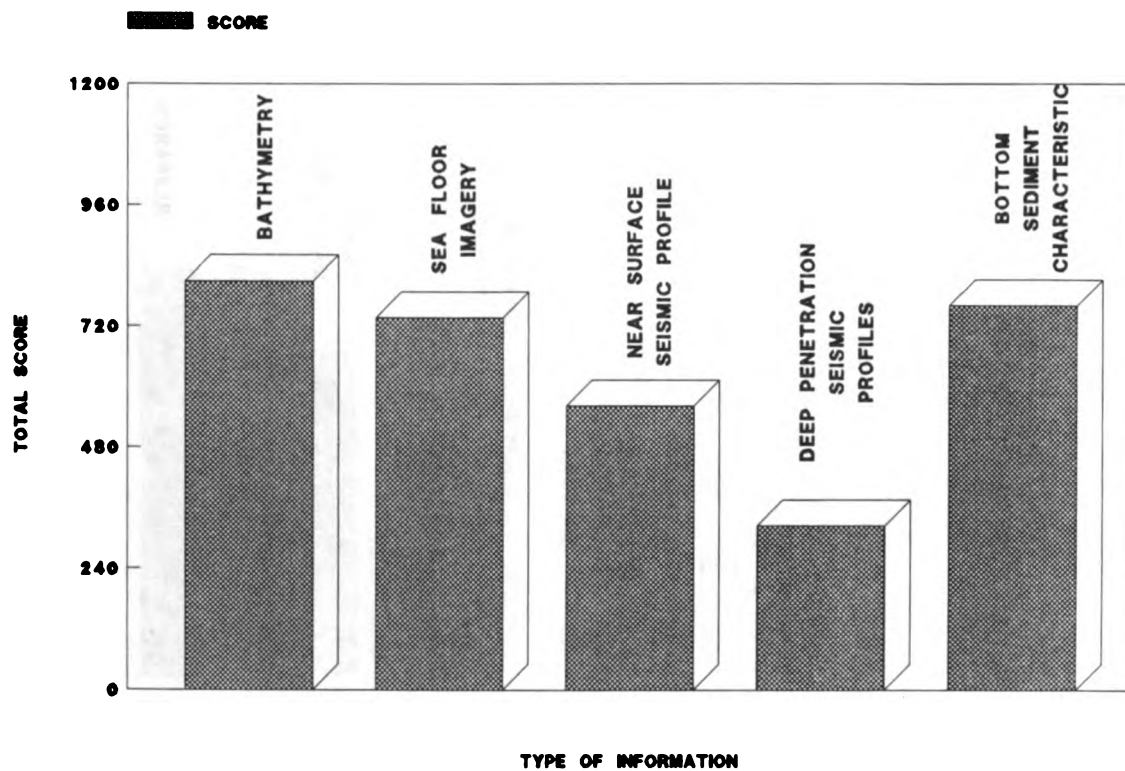
Use	Tasks	Bathymetry		Sea Floor Imagery		Near-surface Seismic Profiles		Deep Penetration Seismic Profiles		Bottom Sediment Characteristics		Totals
		Recon	Site specific	Recon	Site specific	Recon	Site specific	Recon	Site specific	Recon	Site specific	
Oil & Gas	Reserve Assessment Drilling Geohazards Facilities 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
Recon = Reconnaissance												
		Subtotals: 408	401	357	379	291	271	172	153	363	398	
		Totals: 809		736		562		325		761		

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

FIGURE 3A: TOTAL SCORE* IN EACH USE CATEGORY

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

FIGURE 3B: TOTAL SCORE* IN EACH INFORMATION NEED FOR ALL REGIONS



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

FIGURE 4A: North Atlantic Region.* 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	4	3	3	3	4	3	6	4	3	3	36
Minerals	Reserve Assessment Geohazards Production Siting	10	10	9	11	10	12	7	6	12	12	99
Waste Disposal	Site Selection Emplacement Monitoring	11	9	10	10	10	7	6	5	12	10	90
Pipelines	Route Selection Installation Survey	7	9	6	8	6	8	3	4	6	7	64
Cables	Route Selection Installation Survey	8	8	7	7	7	7	5	2	7	7	65
Military		2	1	2	1	2	2	1	1	2	2	16
Biological Resources	Habitat Assessment Monitoring	11	7	13	7	9	3	5	3	13	8	79
Ocean Energy	Site Selection	1	1	1	2	2	2	2	2	2	2	17
Shoreline Management	Location Stabilization	9	7	10	7	9	7	4	1	12	8	74
Cultural Resources	Archaeology Sanctuaries Underwater Recreation	5	5	7	6	5	4	1	1	6	5	45
Research	Structure Geologic Framework Process Studies	13	6	12	7	12	7	10	8	11	5	91
Environmental Assessment	Baseline Studies	11	6	12	6	10	5	6	6	12	7	81

Recon = Reconnaissance

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

*Connecticut (1)
Maine (3)
Massachusetts (3)
New Hampshire (1)
New Jersey (1)
New York (1)
Rhode Island (2)

FIGURE 4B: South Atlantic Region.* 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	9	9	5	8	7	10	9	11	3	7	78
Minerals	Reserve Assessment Geohazards Production Siting	11	13	12	11	11	15	4	7	10	14	108
Waste Disposal	Site Selection Emplacement Monitoring	8	12	6	11	7	7	3	3	7	12	76
Pipelines	Route Selection Installation Survey	7	5	7	6	6	4	—	—	7	7	49
Cables	Route Selection Installation Survey	5	4	4	4	4	3	—	—	5	5	34
Military	Habitat Assessment Monitoring	3	2	3	2	1	—	—	—	1	1	13
Biological Resources	Site Selection	16	15	13	14	3	6	—	3	14	16	100
Ocean Energy	Location Stabilization	1	1	—	1		1		1	1	1	7
Shoreline Management	Archaeology Sanctuaries Underwater Recreation	14	15	9	9	7	7	—	—	14	16	91
Cultural Resources	Structure Geologic Framework Process Studies	9	10	8	7	4	5	—	—	8	10	61
Research	Baseline Studies	10	16	9	13	8	15	10	14	12	13	120
Environmental Assessment		14	14	10	10	5	4	5	2	11	9	84

Recon = Reconnaissance

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

*Delaware (1)
Georgia (2)
Maryland (3)
North Carolina (3)
South Carolina (2)
Virginia (2)

FIGURE 4C: Gulf/Islands Region.* 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	6	6	9	6	10	5	8	5	7	4	66
Minerals	Reserve Assessment Geohazards Production Siting	8	7	8	7	8	7	4	4	8	6	67
Waste Disposal	Site Selection Emplacement Monitoring	4	5	3	6	2	1	—	—	3	6	30
Pipelines	Route Selection Installation Survey	5	6	7	7	5	2	5	2	5	6	50
Cables	Route Selection Installation Survey	4	5	3	4	3	2	1	1	1	4	28
Military	Habitat Assessment Monitoring											43
		6	5	5	6	3	3	1	1	6	7	
Biological Resources	Site Selection	6	6	5	6	4	6	2	3	3	5	46
Ocean Energy	Location Stabilization	13	13	10	11	9	8	6	3	10	12	95
Cultural Resources	Archaeology Sanctuaries Underwater Recreation	6	6	8	6	4	3	1	1	4	3	42
Research	Structure Geologic Framework Process Studies	11	10	11	12	10	10	9	8	10	11	102
Environmental Assessment	Baseline Studies	8	5	8	7	7	4	1	1	7	7	55

Recon = Reconnaissance

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

*Alabama (1)
Florida (2)
Louisiana (2)
Mississippi (2)

Puerto Rico (3)
Texas (3)
Virgin Islands (2)

FIGURE 4D: Pacific Region.* 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	7	7	9	8	9	7	10	7	7	5	76
Minerals	Reserve Assessment Geohazards Production Siting	9	9	9	9	9	9	6	5	12	11	88
Waste Disposal	Site Selection Emplacement Monitoring	8	6	6	8	3	3	3	3	7	10	57
Pipelines	Route Selection Installation Survey	9	7	8	7	8	7	3	3	6	7	65
Cables	Route Selection Installation Survey	8	5	5	6	5	4	1	1	4	5	44
Military		3	2	3	2	2	2	—	—	3	2	19
Biological Resources	Habitat Assessment Monitoring	8	11	6	7	3	4	1	1	9	10	60
Ocean Energy	Site Selection	4	5	4	5	2	3	2	2	2	3	32
Shoreline Management	Location Stabilization	10	8	4	5	3	3	1	1	7	8	50
Cultural Resources	Archaeology Sanctuaries Underwater Recreation	6	9	7	7	3	3	2	1	6	8	52
Research	Structure Geologic Framework Process Studies	7	7	9	8	6	7	9	7	7	8	75
Environmental Assessment	Baseline Studies	8	8	7	6	5	5	4	4	8	8	63

Recon = Reconnaissance

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

*California (3)
Oregon (2)
Washington (2)

FIGURE 4E: Pacific Islands Region.* 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											
Minerals	Reserve Assessment	4	2	3	2	3	1	1	1	4	1	22
	Geohazards Production Siting											
Waste Disposal	Site Selection	2	3	2	2	1	—	—	—	2	2	14
	Emplacement Monitoring											
Pipelines	Route Selection	2	2	2	2	1	1	—	—	2	2	14
	Installation Survey											
Cables	Route Selection	2	2	2	2	1	1	—	—	2	2	14
	Installation Survey											
Military		1	2	1	2	—	—	—	—		2	8
Biological Resources	Habitat Assessment	2	4	1	4					3	2	16
	Monitoring											
Ocean Energy	Site Selection	2	2	1	3	1				2	2	13
Shoreline Management	Location	2	4	2	2	1	1			2	4	16
	Stabilization											
Cultural Resources	Archaeology	2	3	1	2					1	3	12
	Sanctuaries Underwater Recreation											
Research	Structure	1	1	1	1	2	2	2	2	1	1	14
	Geologic Framework Process Studies											
Environmental Assessment	Baseline Studies	1	3	1	3					1	2	11

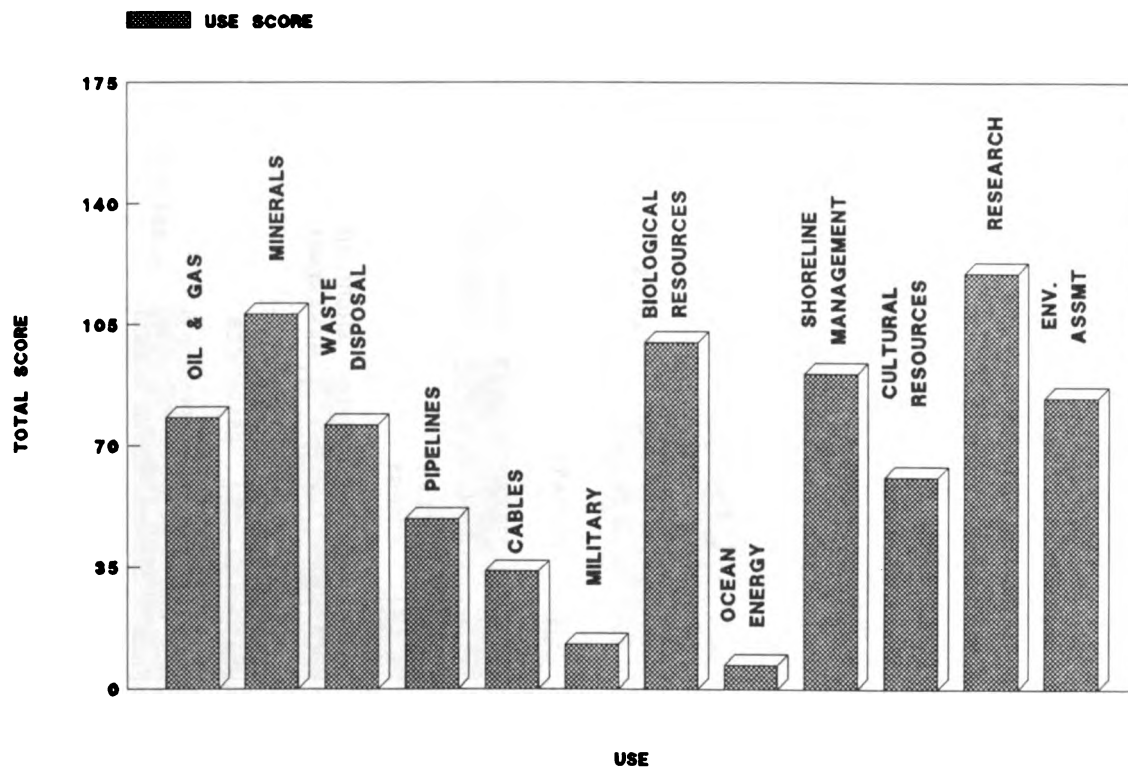
Recon = Reconnaissance

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

*Guam (1)
Hawaii (1)
Northern Marianas
American Samoa

SOUTH ATLANTIC REGION

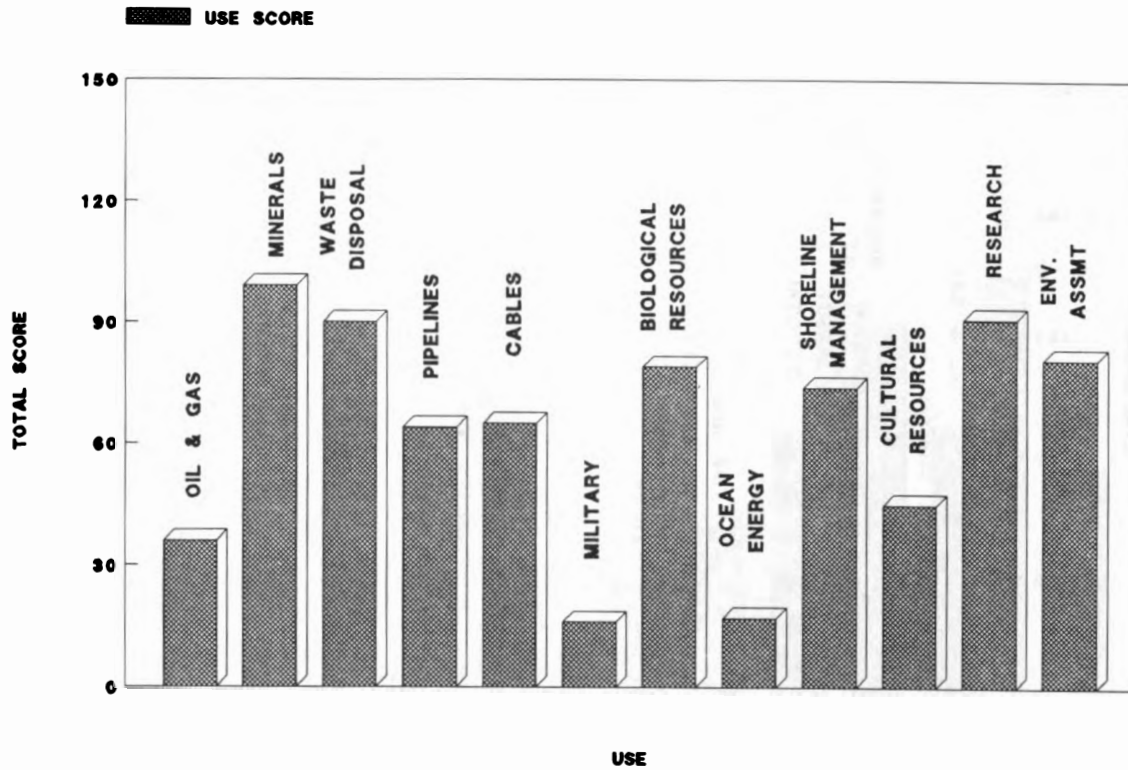
FIGURE 5B: TOTAL SCORE* IN EACH USE CATEGORY



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

NORTH ATLANTIC REGION

FIGURE 5A: TOTAL SCORE* IN EACH USE CATEGORY



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

**FIGURE 6B: Identified Concerns of the States —
Percent of Responses by Region**

USES OF DATA BASED ON COMMENTS IN STATE AGENCY RESPONSES.

REGIONAL SUBTOTALS	Pacific Coast, Alaska, Hawaii	Gulf Coast, Florida, Caribbean	South Atlantic	North Atlantic	Total Number of State Responses
Shoreline Mgmt.	60%	33%	50%	43%	11
Environment and Waste Monitoring	80%	50%	17%	43%	11
Biologic Resources and Fisheries	100%	33%	83%	71%	17
Minerals, Placers and Aggregates	80%	66%	67%	86%	18
Oil and Gas Appraisal and Development	80%	83%	33%	43%	14
Cables and Pipelines		50%			5
Geohazards					2
Waste Disposal					3
Cultural/Recreation					2
Ocean Energy					2
Military					2

**FIGURE 7A: 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								

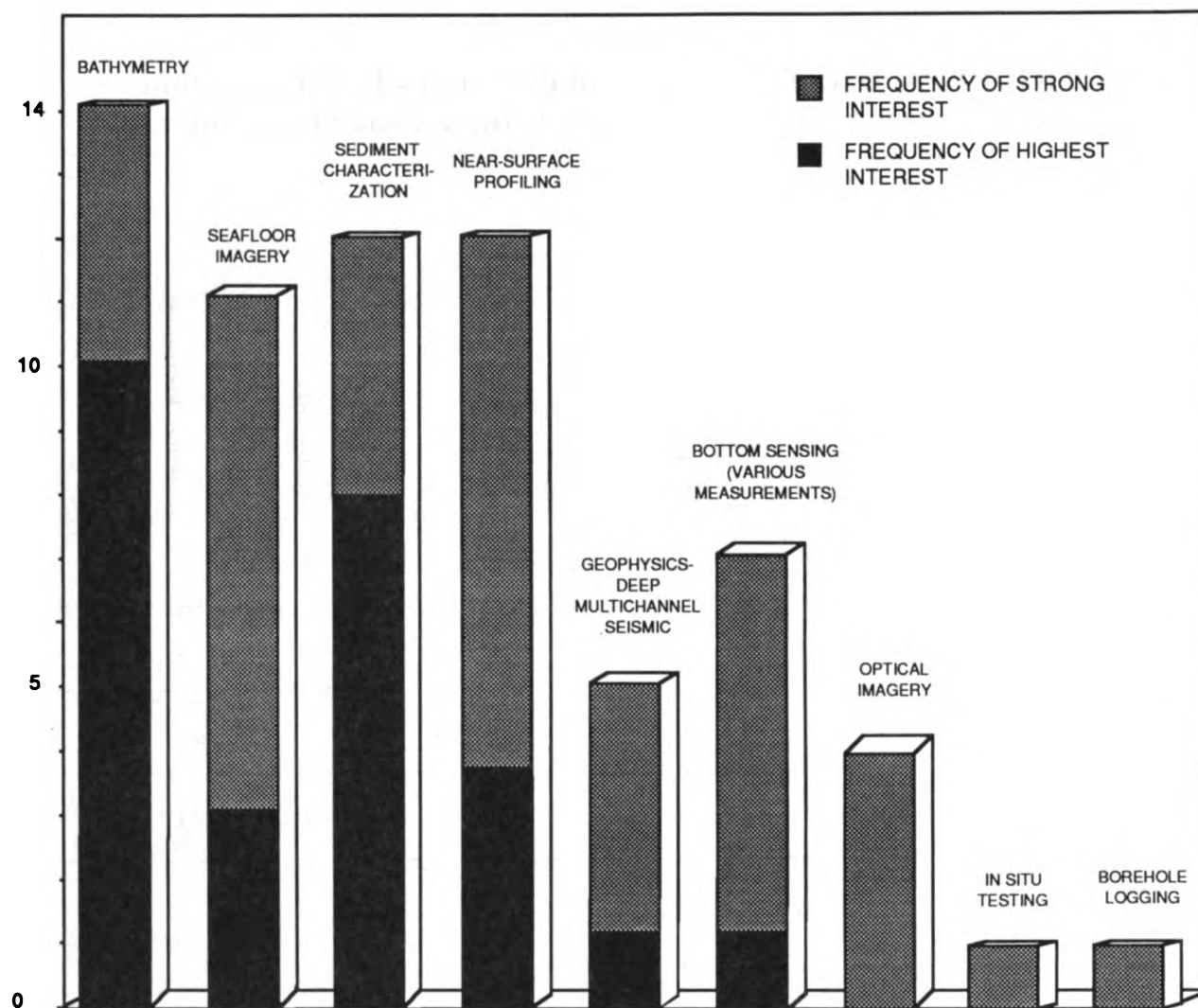


Figure 7B: Relative Frequency of Data Type Required by Principal EEZ Uses
Committee Judgment by Forced Ranking

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

NATIONAL RESEARCH COUNCIL
COMMISSION ON ENGINEERING AND TECHNICAL SYSTEMS
2101 Constitution Avenue Washington, D.C. 20418

APPENDIX A

MARINE BOARD

December 8, 1989
MB-89-943

OFFICE LOCATION:
Georgetown Facility
Room HA 250
2001 Wisconsin Avenue, N.W.
Telephone: (202) 334-3119
Telefax: (202) 334-2620

NAME
ADDRESS

Dear:

The National Research Council has established under its Marine Board a committee on Exclusive Economic Zone (EEZ) Information Needs. The charge of this committee is to identify the needs of the states, industries, and academic researchers for information about the seabed of the EEZ. This advice will be passed to the U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA) and used to guide their Joint Program for Mapping and Research in the EEZ.

Data collection in offshore areas is expensive and, in some cases, requires development of new technologies. In setting priorities for mapping and research and for determining technology development needs, it is important to include the needs of all the potential users of the oceans. The coastal states and U.S. territories are major participants in the Nation's ability to develop and protect its ocean resources.

The attached table is intended to provide our committee with an understanding of the priorities of your state or territory for information in relation to present or planned uses of the EEZ seabed. In addition to your office, the table is being sent to (NOTE: name, affiliation of others in a particular state who received the table).

In your response, please consider the relevant conclusions and positions developed by marine advisory and policy groups in your state.

APPENDIX B
MAILING LIST FOR EEZ INFORMATION NEEDS QUESTIONNAIRE

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