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Workshop on National Needs and Priorities for Ocean Pollution Research and Development and Monitoring

Committee on Ocean Pollution Research and Development and Monitoring

November 14-16, 1978
Tysons Corner, Virginia

PROCEEDINGS
OF THE
WORKSHOP ON NATIONAL NEEDS AND PRIORITIES
FOR OCEAN POLLUTION RESEARCH AND DEVELOPMENT
AND MONITORING

NOVEMBER 14 TO 16, 1979
TYSON'S CORNER, VIRGINIA

COMMITTEE ON OCEAN POLLUTION
RESEARCH AND DEVELOPMENT
AND MONITORING

ABSTRACT

The Workshop on National Needs and Priorities for Ocean Pollution Research and Development and Monitoring was organized in response to the National Ocean Pollution Research and Development and Monitoring Planning Act (PL 95-273).

This Act calls for the enactment of a comprehensive, five-year Federal plan addressing ocean pollution research and development and monitoring. Identification of national needs and problems associated with ocean pollution is the first step in establishing a realistic, balanced program in these areas.

The Workshop brought together a variety of users of ocean pollution information. They were to identify and rank information needs for consideration in the development of the Plan.

The six panels were organized along ocean use lines: Energy Generating Systems, Living Resources, Transportation, Waste Disposal, Mineral Resources and Coastal Development and Recreation. Each panel discussed in varying levels of detail the level and location of activity, its value, environmental consequences of pollution, decision processes relating to ocean pollution and limiting factors.

Concern for more knowledge on fate and effects of toxic pollutants, extrapolation of laboratory findings to on-site realities, and fundamentals of marine ecology, chemistry and physics pervaded all discussions. Several specific priorities addressed the problem of evaluating the oceans' capacity to assimilate degradable materials. A better understanding of the economic aspects of effects and alternatives, a clarification of the institutional structures and functions relating to ocean pollution and the development of a more effective public awareness program was also called for.

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SECTION 1

INTRODUCTION

OCEAN POLLUTION AND OCEAN USE

Ocean pollution is the inevitable result of human activity. While most ocean pollution comes from sources which are dissociated from direct ocean use--from urban and agricultural runoff, for example--some is directly linked to man's exploitation of the ocean and its coasts for food, energy, avenues of commerce and esthetic enjoyment.

Unlike land-based resources, where property rights exist, the oceans are a commons and government is the custodian for society. Most decisions about ocean space thus rest with government, particularly with the Federal government. A recent study of United States ocean policy conducted by the U.S. Department of Commerce identified some 21 organizations in six departments and five independent Federal agencies involved in decisions on how ocean space is used. These agencies preside over 200 separate statutes in the U.S. Code.

All three branches of the Federal government have involved themselves with issues relating to ocean pollution. The Executive Branch has influenced such matters as permits to dredge, dump or discharge waste materials. The Legislative Branch has passed laws which affect the use of the marine environment. The Judicial Branch has been evaluating the adverse consequences of certain kinds of ocean use; for example, those which sometimes result from transport of hazardous materials. In many cases, these decisions have suffered from the lack of objective information to support them.

ACTIONS BY CONGRESS

Wise use of the oceans is directly dependent upon a knowledge of the consequences of each use. Unfortunately, whereas Federal government both nurtures and initiates extensive ocean pollution research, development and monitoring which can yield such knowledge, these activities are often uncoordinated and can result in duplication of information or in information which is not available when or where it is needed.

Therefore, in the spring of 1978, Congress enacted the National Ocean Pollution Research and Development and Monitoring Planning Act (PL 95-273). The Act mandates development of a five-year plan for an inclusive Federal program in ocean pollution research and development and monitoring. This calls for:

1. An assessment and ordering of national needs and problems pertaining to ocean pollution research and development and monitoring
2. An inventory of existing Federal programs, resources and facilities
3. Policy recommendations
4. A budget review

The plan generally seeks to assure that the Federal program for ocean pollution research, development and monitoring provides the knowledge which all concerned groups would need in order to make better decisions on ocean-use activities that may pollute.

PURPOSE OF WORKSHOP

This workshop was conducted to gather information on national needs and priorities. It brought together representatives from the public and private sectors--Federal, state and local representatives; representatives from industry, as well as from citizens groups--who are users of information on pollution in the marine environment. Drawing from their experience, the user groups were to articulate the kinds and importance of information and data needed. The information gained from the Workshop, along with information from scientists and the Federal agencies, was to be used to develop the Federal Plan.

WORKSHOP ORGANIZATION AND TASKS

At the outset, the following six ocean-use categories were identified:

- Energy Generating Systems
- Living Resources
- Marine Transportation
- Waste Disposal
- Mineral Resources
- Coastal Development and Recreation

These activity areas provided the basis for organizing the Workshop into panels. Prior to the Workshop, background information on national needs and problems for each area was distributed for the panels' consideration.

A statement of needs and problems for any area of ocean use should focus on the information requirements that would improve our understanding of the consequences of decisions. To be useful for planning, this statement should include the following considerations:

1. Level and Location of the Ocean-Use Activity

   Ocean-use activities that cause pollution vary in space and time. The intensity of an activity such as ocean dumping or oil and gas development varies with the coastal region in question, and pollution problems are often region-specific. Research and monitoring programs are usually regional as well. The immediacy of an activity and related governmental decisions are important to research planning. The lead time granted and available for adequate research and development programs on such ocean-use activities as OCS leasing and waste disposal permits is often stinting.

2. Value and Importance of the Ocean-Use Activity

   Knowledge of the relative value that society assigns to ocean-use activities is essential for determining what compromises have to be considered between ocean uses and pollution consequences.

3. Polluting Consequences of the Activity

   Identifying the polluting consequences of each activity is intrinsic to analyzing the total risk posed to the environment and defining the ultimate losses that society may suffer.

4. Factors Limiting Good Decisions

   Major decisions about activities that may cause pollution are made in a climate of uncertainty. This occurs because a full understanding of the amount or risk of a pollutant's discharge, transport, transformation, environmental vulnerability, technology development and the socioeconomic aspects of potential damage is lacking. Limitations on the quality of decisions may fall into the following categories:

   A. Scientific Data and Information--
      Knowledge of conditions and trends; physical and chemical processes; structure and dynamics of vulnerable populations; tolerance to pollution; ecosystem dynamics; and risk analysis.
   B. Technology--
      Instrumentation; engineering risk analysis; research platforms; and analytical and quality control techniques, pollution treatment or mitigation developments.
   C. Economics--
      Value of resources; costs of abatement and prevention; projections of resource supply and demand; and activity analysis.
   D. Social and Institutional Factors--
      Jurisdictional problems; public awareness; governmental authority and function; quality of life.

SETTING PRIORITIES

One of the most difficult tasks in any planning process is setting priorities among needs. Because many of the needs for research, development and monitoring are interrelated, it would be arbitrary to say that one is more important than another. It is also difficult to distinguish the wants of researchers from the needs of society. Each facet of the polluting process--sources, fates, effects, damages--may be the subject of research, development or monitoring. In addition, it may be difficult to weigh the threats from one form of ocean use against another. For instance, how does one determine whether the pollution threats from OCS activities are greater than those from oil tankers? In considering priorities, the Panels were asked to take into account the following:

1. Intensity and regional distribution of the activity
2. Value and importance of activity
3. Value and vulnerability of resources at risk
4. Immediacy of threats
5. Extent to which research, development or monitoring efforts may contribute to improved decisions
6. Time required to develop useful information.

WORKSHOP PRODUCTS AND SUGGESTIONS

Ocean uses are interrelated, and therefore, pollution caused by one of them may have a synergistic effect on others. Since the panels were organized along ocean-use lines, their discussions often overlapped. The Marine Waste Panel mentioned riverine pollution, which had been assigned principally to the Coastal Development and Recreation Panel. The Living Resources Panel dealt with waste disposal, transportation and energy systems, often not confining discussion to the effects of these activities on living resources. The Coastal Development and Recreation Panel covered most of the same topics considered in the other panels, but related these to the coastal zone. The needs developed in each panel reflect this interrelationship and are therefore often repeated.

The panels were given considerable freedom to develop a panel report which provided a statement of needs for research and and development and monitoring. Although they were asked to consider the factors mentioned above (level and location of activity, limiting factors, etc.), they did not have to bear with a formal structure which could inhibit creativity. Naturally, this resulted in six different panel reports with six differing levels of detail.

Also, despite the fact that the panels were given general guidance regarding criteria for ranking needs, each chose its own method; the most elaborate of which was generated by the Energy Generating Systems Panel. Other panels such as Mineral Resources chose to rank only those needs which the panel members could evaluate within the context of their own expertise. Many panels identified areas of expertise not represented on their panels and recommended that the preparers of the Federal Plan consult suitable representatives from them.

In general, the panels suggested that future workshops consider the following:

- Adequate notice of the meeting should be given to the participants and sufficent time provided for review of briefing materials
- Since the needs generated by the panels may already be fulfilled by ongoing work, background information on the current program should be given to participants. This kind of information was not available for distribution to the Workshop participants

SECTION 2

SUMMARY AND CONCLUSIONS

All panels agreed that continued public participation in the development of the Federal Plan for ocean pollution research and development and monitoring, and its bi-annual revision, is essential. In particular, they proposed that this initial five-year plan be reviewed critically and intensively by all affected parties, and modification made. Most Workshop participants expressed a desire to remain involved. Some suggested methods for increasing public participation, e.g., briefings on the Plan, and its review by an audience broader than that represented at the Workshop.

In addition, the panels stated that the capabilities and research of industry and academia, as well as that of international organizations, should be considered in the preparation of the Plan.

Regarding the users of research, development and monitoring information, several panels noted that while the requirements of those who make decisions are important, public awareness--providing knowledge to broad sectors of the public--is also of value. An effective public awareness program would alleviate public misunderstanding or mistrust of scientists, industry and government officials.

The Panels' research, development and monitoring needs evolved from consideration of the larger, societal context of marine-related activities. They were not limited to science and technology alone. Thus, several panels listed as needs a better understanding of economic aspects of effects and alternatives, and clarification of the institutional structure and functions particularly given the maze of Federal agency mandates. The breadth of approach was further evident from the willingness of some panels to relate marine pollution effects to land activities. Economics of landfill disposal and viability of pathogens in river waters are diverse examples of the connection between land-based processes causing eventual marine pollution.

Regarding research, development, and monitoring specifically keyed to science and technology, the panels uniformly took note of the need for more and better information on which to base rational decisions. Less well recognized was the evolutionary nature of scientific understanding and of technology as related to societal and institutional stability. The need for a flexible insititutional process was articulated. While the panels arranged varying priorities on research and development according to their topical assignments, they voiced deep concern about the need for more knowledge of fate and effects of toxic pollutants, extrapolation of laboratory findings to on-site realities, and fundamentals of marine ecology, chemistry and physics. Many specific research priorities implicitly address the problem of evaluating the capacity of the oceans to assimilate degradable materials.

The fact that monitoring needs were not always distinguished clearly from research and development needs may reflect the panels' appreciation of the interrelationship among those activities. Uniform monitoring standards and better monitoring indices were listed as high priorities in most panel reports.

ENERGY GENERATING SYSTEMS

After registering concern about the dangers of focusing too closely on the needs of government officials, the Panel assigned priorities to eleven technologies to be addressed in their discussions. These were initially ranked according to the immediacy of their application in the marine environment. The top six were: nuclear-fuel-powered plants, fossil-fuel plants, geothermal plants, pumped storage systems, the OTEC system and marine biomass. The remaining five were waves, tides, currents, salinity gradient and satellite power systems. The group also ranked the eleven technologies according to their probable environmental impact.

Some 55 research and development and monitoring needs were identified and ranked. The basic criteria of immediacy of technological application, scale of probable environmental harm, and existing knowledge of pollution effects were used to assess these needs. Thirteen needs were assigned a high priority, 20 medium, and 22 low. The highest priority needs were those associated with coastal energy generating systems for fossil- and nuclear-fueled plants, both on and offshore. These needs focused on thermal effects, the effects and behavior of radionuclides, and low-level and chronic effects from the operation of these plants. The need both to develop methods for measuring effects more accurately and to look at aggregated effects in addition to localized site-specific conditions was pinpointed.

LIVING RESOURCES

The scope of recommendations from the Living Resources Panel extended well beyond pollution from the seafood industry--their initial working concept of this use. Interactions of living marine resources with other uses of the oceans were discussed. A list of pollutants was scanned and ranked according to research needs. Synthetic organic and toxic metal compounds were viewed as pivotal. General and specific programs for research, development, and monitoring needs were recommended.

Three broad areas of research which should be synchronized were identified:

- Description and measurement of critical, functional components of undisturbed and perturbed ecosystems
- Measurement of rates and interactions associated with processes and fluxes within individual organisms and in major ecosystems
- Determination and evaluation of importance of effects, both acute and chronic, on components, processes and fluxes that constitute significant alterations in organisms and ecosystems.

Thirteen specific needs and problems were identified and given priority rankings. The highest priority projects concerned: 1) standardization of marine pollutant analysis methods; 2) source control of hazardous materials before release; and 3) distribution, nature and impact of certain pollutants.

Decisions about the environment should be founded on knowledge of existing contamination, its rate of increase or decrease, and its effects on organisms and ecosystems under differing environmental conditions. Pollution-oriented research activities should be organized around a closely-coordinated, interactive program of monitoring and research. Information must be made available to and utilized by appropriate regulatory, environmental and industrial officials.

MARINE TRANSPORTATION

Although they concurred that fate and effects are crucial areas, particularly for oil and hazardous substances, the Marine Transportation Panel felt unqualified to develop it in depth. Rather, the panel identified needed prevention and mitigation work in the marine transportation of hazardous substances, broadly defined to include every stage of handling in connection with such transportation.

It was agreed that any effective regulatory regime required: 1) the control and limitation of normal discharges from everyday operations; 2) the prevention or mitigation of accidental discharges; and 3) the assurance of an effective liability, cleanup and compensation regime for victims of marine transportation-related pollution damages.

In examining and listing prevention and mitigation needs, the Panel divided marine transportation consequences into hazardous-substance spills and oil pollution. The major need in the area of hazardous-substance spills was defined as better spill information and trend analysis. Only after such analyses would it be possible to regulate transportation activities rationally. In general, the Panel expressed more concern about chemicals than oils.

A list of needs in the area of pollution from marine transportation was devised featuring eight major categories: cargoes, vessels/equipment, personnel, terminals, environmental operating conditions, communications/navigation, institutional and legal ramifications, and accident response. Within these categories, several needs were ranked in terms of high, medium or low priority. The Panel emphasized the importance of personnel and the institutional and legal ramifications of the issue. A profile of standard requirements, a study of owner/crew relationships, reasons for failures, and examination of normal and emergency procedures, and procedures for training and regulating pilots were cited as personnel needs. Institutional and legal needs included: salvage law compensation, better monitoring capability for operational discharge, substandard ship identification, international enforcement capability, and liability compensation.

MARINE WASTE DISPOSAL

The Panel accepted a broad definition of marine waste disposal which encompassed disposal of all sludges, dredged materials, radioactive wastes, point and non-point sources, and riverine pollution. Ocean dumping, ocean outfalls, and riverine pollution received particular emphasis. Radioactivity was seen as a separate category of both waste and process.

The Panel also discussed statutory authorities and agencies involved in decisions about marine waste disposal and environmental quality considerations. The interaction between land and marine waste disposal and the need for a balanced consideration of both approaches were discussed intermittently.

In developing a Federal research, development and monitoring program pertinent to waste disposal, the Panel recommended:

- Development of an inventory of the sources of pollutants by location and type of discharge

- Quantification measurement of the amounts, rates and types of pollutants added to the marine environment, including riverine sources
- Evaluation of effects, with more on-site data collection
- Definitions of the assimilative capacity for degradable materials in relation to other uses of the marine environment
- Development of institutional frameworks to regulate marine environmental uses on the basis of assimilative capacities
- Improvement of public awareness as a facet of all Federal ocean pollution programs

Seventeen research, development and monitoring needs which bear upon ocean dumping, outfalls, radioactive wastes, and riverine pollutants were identified and prioritized. The six needs assigned a high priority in all four categories were:

- Evaluation of potential health effects of persistent pollutants and nuclear wastes (including carcinogens, teratogens and mutagens)
- Evaluation of distribution, persistence and pathways to man of pathogens
- Development of better analytical quality control and standardized monitoring methods
- Development of public awareness programs
- Development of feasible methods for lessening the amounts and types of materials reaching the ocean in excess of the capacity of the ocean to assimilate those materials
- Monitoring of existing ocean disposal sites according to requirements of EPA criteria

Research and development needs were not clearly distinguished from monitoring needs, which reflects the interrelationship of these activities.

MINERAL RESOURCES

The Panel discussed a wide range of mineral resource extraction activities and identified a variety of minerals whose extraction processes cause ocean pollution. Discussion focused to a great extent on information needs for OCS oil and gas extraction and deep seabed mining. A limited discussion of sand and gravel mining also ensued.

The Panel identified Federal agencies and other organizations involved in decisions about mineral resources and noted that much information already exists in reports on technologies.

Singular emphasis was placed on generating a list of needs. Because the Panel did not consider itself qualified to address relative priorities among all mineral areas, they assigned priorities only within the oil and gas and deep seabed mining categories.

Highest priorities for oil and gas extraction were identified as:

- Research and development related to catastrophic oil spills and blowouts, particularly in the Arctic
- Determination of effects of long-term, low-level, chronic pollution resulting from spills, production and operational discharges; and development of predictive models
- Development of bioassay techniques for on-site monitoring

Highest priorities for deep seabed mining were identified as:

- Determination of the fate and effects of surface discharged sediments
- Evaluation of the necessity for shunting discharges below the euphotic zone

Additional needs were identified for sand and gravel mining, desalination and salt dome extraction.

COASTAL DEVELOPMENT AND RECREATION

The Coastal Development and Recreation Panel discussed: 1) point sources of pollution, 2) non-point sources of pollution, 3) habitat alteration and destruction of biota, 4) water diversion, 5) shore stabilization, and 6) facility siting. National decision processes for managing the coastal zone were also discussed.

Research, development and monitoring needs were divided into 1) physical, biological and chemical; and 2) economic and institutional. Physical, biological and chemical needs were further subdivided into information on: pollutant discharge, transport and fate, and effects. High priority was assigned to: developing methods for estimating pollutants such as synthetic organics and heavy metals in existing and future pollutant discharges from municipal and industrial outfalls, and agricultural runoff; models which incorporate cumulative pollutant effects and ambient ecological conditions; human health effects of microorganisms and synthetic organic compounds; evaluations of indicator organisms; and procedures for detecting microorganisms, fossil fuel compounds, heavy metals and synthetic organics.

General economic and institutional needs were identified but not allocated priority order. These included the study of costs of alternative pollution control plans and regional temporal and demographic factors affecting them. The benefits derived from goods and services whose production might be controlled by these plans for environmental purposes were also cited. Management-model structure, the decision process and the performance effectiveness of of existing institutions and programs were also discussed.

SECTION 3

INTRODUCTORY REMARKS

CHARLES WARREN, CHAIRMAN

COUNCIL ON ENVIRONMENTAL QUALITY

Tyson's Corner, Virginia

November 14, 1978

There is doggerel by Christopher Morley which says:

"If you haven't any ideas
Don't worry.
You can get along without them--
Many of the nicest people do."

While this may be a harmless way to approach a social event, it definitely will not do for a productive workshop, especially on a subject as portentous as identifying the national needs and problems associated with ocean pollution research and development and monitoring.

The National Ocean Pollution Research and Development and Monitoring Planning Act of 1978 lays out a formidable task which you are to tackle. As you know, the Act requires the formulation of a comprehensive five-year plan to identify those national needs and problems, relating to ocean pollution which presently exist and will arise during a five-year period; and to establish priorities based upon the value and cost of information which can be obtained from specific ocean pollution research and development and monitoring programs and projects. As if this weren't enough, the Act generously gives you everything from the coastal zone to the high seas to be concerned with.

With such a task before you, I suggest that "if you haven't any ideas" you are entitled to worry, no matter what the poem says. The task is not only broad but astoundingly complex.

The earth is a dynamic entity--an interlocking system of land masses, the atmosphere and the oceans. The fundamental problems affecting the world's oceans cannot be viewed from the marine perspective alone. For example, we are concerned with oil spills not only in the water but on beaches and in marshes as well. Likewise, fifty million metric tons of particulate pollutants from industry fall out of the atmosphere onto the surface of the world's oceans each year. Still another example is the excessive erosion and runoff of soils--resulting from failure or neglect of careful husbandry of the land--which constitute a major part of the twenty billion metric tons of suspended solids that the world's rivers pour into the oceans each year. By the remarkable perversity of Mother Nature, we manage to create still another problem when the dams we build retard the natural flow of silt and sands, causing sand starvation and beach erosion.

Consequently, my first suggestion to you is to think globally--be expansive in identifying the problems we ought to be concerned with. Recognize that the oceans are part of a global, interconnected system. Your responsibility does not stop at the water's edge.

Let me offer a striking example. CEQ, with the assistance and cooperation of many other federal agencies, is engaged in a massive assessment of trends in the world's resources, population, and environment up to the year 2000, and of our government's ability to make useful projections of these trends. This Global 2000 study has identified the accumulation of carbon dioxide in the atmosphere as potentially the foremost environmental problem of the coming decades. This observation is certainly not unique to us--I bring it up to indicate that even this problem, which is typically viewed as an atmospheric problem, is fundamentally linked to land and water. A land-use issue--specifically, loss of the world's forests--has now come to occupy a large part of the scientific and policy deliberations for the potential buildup of carbon dioxide in the atmosphere. But another component, which certainly relates to your task, is the role of the oceans in the transport and sequestering of atmospheric CO_2. Over geologic time, the ocean's role is of major consequence. However, considering the extremely rapid pace of human modifications of the global carbon cycle, the time scale of ocean effects may be too long to be of immediate significance. A high priority on this particular problem would have to be weighed in the value and cost criterion of the Act. However, its consideration suggests a scale against which the enormity of man's actions on the marine environment can be measured.

The participants in this Workshop represent a broad spectrum of disciplines, home institutions and types of professional responsibility. The wording of the Act itself encourages you to adopt an expansive view of your task. The phase "research and development and monitoring" makes it clear that an integrated spectrum of activities is to be addressed in identifying national needs and problems. As was shown in this nation's attempt to develop our OCS oil reserves, development cannot proceed without an adequate information base generated by a monitoring program. In turn, a monitoring program which will be useful for problem solving and decision making must be derived from an appropriately designed research program. There is a tendency for the practitioners of these various arts not to look past the bounds of their own immediate responsibilities. An engineer can plan for development without environmental data. A marine scientist can create an experimental design of narrow academic interest. The regulatory scientist can gather voluminous data which narrowly satisfies regulations. Not only can these actions take place, we all know they do take place; but in isolation they are inadequate to the formulation of national policy. The Act provides the participants of this Workshop with a unique opportunity to synthesize the policy options in research and development and monitoring and to formulate a statement of national needs and priorities which surpasses the parochialism of your own professional disciplines or the limited missions of your respective agencies and institutions.

Let's consider research.

One of the great strengths of this nation has been the ability of its academic institutions to not only respond to national needs, but in fact, to lead in the identification of these needs and be truly responsive to fulfilling them. Satisfaction of parts of the five-year plan to a large extent will fall upon our academic scientists. There is sometimes a rather narrow view of the role of scientific research which is not immediately directed at applications. Historically as a nation we have reaped huge practical benefits from allowing the research community to identify and solve the problems it considers to be important. It is useful, however, for researchers to be aware of the overall objectives of our society--that is, national policy--in formulating their research programs. A major benefit of the Plan to which this Workshop is contributing will be that it provides a context in which the planning of marine research can take place.

The linkage between policy and research works both ways. Not only should the researcher recognize the possible social importance of his work, the policymaker should recognize that in an area as technically complex as marine pollution, his decisions are strongly based on state-of-the-art technology. A good example can be found in the detection and measurement of pesticides. The development of the gas chromatograph with an electron-capture detector provided the scientists with the tools, and the policymaker with the information, to recognize and begin to correct the environmental degradation due to chlorinated hydrocarbon pesticide pollution. When it was found that the pesticide dieldrin could not be separated from degradation products of DDT with available gas chromatography, new column coatings were developed to distinguish between the chemicals. Other improvements enabled separation of PCBs and other chlorinated hydrocarbons. All these technological improvements were the result of painstaking research. If this research had not been done, our ability to define the nature and extent of the PCB problem in the ocean or to monitor in the marine environment the results of DDT production declines would be far less sophisticated, if it existed at all.

Therefore, to balance my suggestion to the technical participants to be goal-oriented and policy-aware, I also am advising the participants in this Workshop who represent the marine policy community to recognize that the five-year plan must accommodate the laborous block by block building of our technical capability, which, in turn, rests upon the work of the research scientist.

Let's consider development, and its relationship to ocean pollution research and monitoring.

A major reason why the passage of the National Ocean Pollution Research and Development and Monitoring Planning Act of 1978 is so timely is the pressures for development in the world's oceans are increasing at an alarming rate. Development affects the marine environment both <u>passively</u>, in that the ocean is the recipient of our technological debris ranging from chlorinated hydrocarbon molecules to plastic six-pack dispensers, as well as <u>actively</u>, as by our extraction of marine resources.

A topic such as ocean mining where many fundamental policy issues are still being formulated poses great difficulties for you in trying to assess national needs and problems priorities. The technology of marine mining ranges from shore-side processing of minerals to deep-ocean extraction, from oil well pumping to nodule extraction. Our current knowledge and ability to identify and deal with many of the inevitable development problems leaves a great deal to be desired. For example, the 1977 report of UN marine pollution experts says "Present estimates of pollution from marine mining are largely unsubstantiated. In some cases they are reasonable deductions from established facts; in others, extrapolations--sometimes unjustified--have been made from studies in other fields. Other less obvious impacts may be disclosed by field investigations of specific activities." It also states that, "the biological effects of marine mining are very site-specific. In many cases intensive and long-term study would be required to develop adequate measurement and prediction capabilities."

In that report the footnote relating to special pollution considerations covers three and a half pages. Possible causes for alarm for extracting different mineral ranges from construction of large artificial islands to the use of potassium cyanide.

In defining needs, we must keep in mind not only the integral nature of the problems we face, but also the links to policy. Let us take offshore development of oil and gas as an illustration. Oil pollution of the oceans and coastal waters has been relatively well studied--although of course gaps in knowledge remain, and the book on marine oil pollution is far from closed.

Designing further research on the existing foundation, to guide decisions on where and how to drill for oil offshore, takes an understanding of oil technology and government regulation of the industry, as well as biology. For example, if we are planning to drill in a harsh environment such as Alaska's arctic and subarctic water, we need more than an inventory of the local birds and marine animals, plus general observations on how oil spills affect these creatures. We need specific information on where and when valuable crabs spawn, or rare birds nest. Such information lays the basis for regulations that keep drilling platforms out of sensitive areas, or suspend the operation of helicopters and workboats at sensitive times.

Control of oil pollution from tankers also rests on a broad, interdisciplinary research base. Of the estimated 5 million metric tons of oil entering the world's oceans every year as a direct result of human activities, about 2 million comes from tankers. To name a few of the specialists contributing toward measures to stem the effects of this outflow, there are: <u>ornithologists</u>, recording the decline of puffins, razorbills, and auks in the great tanker routes of northern Europe; <u>insurance accountants</u>, tallying worldwide tanker accidents; <u>naval architects</u>, designing ships that keep oil out of the ballast water and tank washing which are discharged into the oceans; <u>marine engineers</u>, <u>fisheries scientists</u>, and <u>international lawyers</u>.

Given the dynamic policy situation for fuels and non-fuels minerals in the marine environment, coupled with the pressures for large-scale development and the present inadequate state of assessment knowledge, this may prove to be one of the more knotty areas for you to deal with in laying out national needs and priorities.

The extraction of energy minerals from the ocean floor is not the only burden that energy technology places on the marine environment. Our continuing appetite for energy, if not curbed, may lead us to place still additional burdens on the marine environment. Off the coast of my home state, California, scientists are investigating the harvesting of algae to see if this might become a source of gas by bioconversion technology. While one can conceive of potential environmental problems resulting from large-scale ocean farming for biomass fuels, there are other energy technologies under consideration which warrant your even closer attention.

Ocean Thermal Energy Conversion (OTEC) uses the temperature difference between surface and cold, deep ocean water to produce electric power. Suitable sites exist 140 miles off the west coast of Florida, around Hawaii and Puerto Rico, off Brazil and a somewhat less desirable site off Louisiana.

Allow me to quote from recent DOE testimony before the Subcommittee on Advanced Energy Technologies.

> "Further environmental investigations in two major categories are required for large-scale (several 300 MW plants) deployment of OTEC. These are:
>
> 1) Biological/Ecological Issues. Consideration must be given to the possible impact on ocean flora and fauna due to large volume discharge of potentially toxic cleaning agents. Intrainment and entrapment on OTEC intake screens also pose problems to be addressed.
>
> 2) Physical/Climatic Issues. The potential alteration of the thermal structure in ocean basins such as the Gulf of Mexico could lead to an alteration of the present equilibrium in the air/sea exchange process which in turn could affect climate. Injection of nutrient-rich bottom water into near-surface zones could have either beneficial (mariculture) or detrimental (eutrophication) effects."

I think it premature to guess whether or not OTEC will ever contribute significantly to this nation's energy needs. What is important to you, however, is that research will be progressing during the term of the five-year plan.

The potential impacts on the marine environment are large, and the research lead time to address these problems is long.

I mention OTEC only as an example of how new and changing technology can have a major impact on the formulation of any plan embodying national needs and priorities. Unfortunately, it is very easy to find examples of unknown impacts of future technology.

I have devoted this much time to development pressures because the range of these activities will make the setting of needs and priorities difficult.

A word about monitoring.

The Act very wisely identifies monitoring as a subject equal in importance to both research and development. I am also pleased to see that the Task Force has established a major subcommittee to address the topic. Monitoring tends not to be a glamorous subject. In activities less wisely structured than this, it tends to achieve a low priority and not fare well in budget considerations. The inevitable result of this is that, when information is needed to make decisions on environmental problems, it does not exist.

Monitoring is very important in the marine environment. Because of the physical magnitude of the oceans and the enormous time scale of some natural marine processes, the detection of man-induced change and the following consequences throughout the marine ecosystem requires a strong exercise of ingenuity by scientists.

Man's activities result in a ten-fold increase of many naturally-occurring minerals entering the world's oceans. We have introduced a billion curies of radioactivity. The annual production rate for individual classes of halogenated hydrocarbons is measured in thousands of tons per year <u>each</u>, much of which eventually winds up in marine environment where its persistence permits it to accumulate. When one considers that some marine organisms can accumulate pollutants many thousandfold over ambient concentration, it is not difficult to assess the importance of monitoring the marine environment.

There are a variety of monitoring activities taking place. Some such as Mussell Watch are very broad in design and purpose. Others, such as self-monitoring by waste dumping permittees, are much more narrowly conceived.

Monitoring cuts across all the major issues which will be dealt with by this Workshop. As you begin your discussion of each of the straw documents that will form the basis of your agenda, be sure to establish clearly the role that monitoring will have to play over the next five years. Otherwise, in retrospect this Workshop may be viewed as having laid out the problems, but not identifying the means of providing information to solve them.

Lastly, a word about problem-solving.

I have been using examples which might make it appear that some problems are primarily research problems; others, development; and still others, monitoring problems. This is, of course, rarely--if ever--the case. Rather, problem identification and solution requires continuous interaction among government policymakers, those engaged in development activities, and of course, scientists involved with research and monitoring.

The dumping of debris into the oceans provides an interesting blend of research, development, and monitoring with substantial overtones of public awareness, governmental policies, and economic costs. An examination of the map of U.S. ocean-dumping sites reveals such interesting names as the Philadelphia Sludge Site, the New York Acid Site, the Gulf Incineration Site, and the New York Cellar Dirt Site.

The problems of ocean dumping have received their share of policy-level consideration. In our country, the Marine Protection, Research and Sanctuaries Act of 1972; the Resource Conservation and Recovery Act of 1976; and the Clean Water Act enable the federal government to regulate ocean dumping activities. Internationally, the Convention on Prevention of Marine Pollution by Dumping of Wastes and Other Matter (Ocean Dumping Convention) has been in effect for three years.

Progress has been made insofar as all municipal wastewater treatment plant sludge dumping should be terminated by the end of 1981 according to the most recent EPA report under the Marine Protection, Research and Sanctuaries Act. During 1977 there was a 12 percent drop in ocean dumping, and by the end of that year, the the last permittee having an interim dumping permit ceased dumping in the Gulf of Mexico.

Despite all this progress, 1977 also saw more than seven million tons of waste dumped into the ocean by the U.S. Five million tons of this was sewage sludge, with the New York Bight receiving most of this material.

The importance of a multi-year plan to establish priorities is well exemplified by the New York Bight. Despite the 1683 ordinance of the New York City's Common Council which prohibited fouling the harbors with "any dung, draught, (or) dyrte," New York was dumping refuse off Long Island before 1900. Things got to the point that in 1931 the Supreme Court forbade further discharge by New York of floatable wastes. Scientists have identified pollution damage to marine biota off New York since the 1880's. By the late 1960's and early 70's the scientific community was questioning the extent and nature of serious environmental contamination in the Bight. In 1970 the first instance of closure of a fishery for shellfish on the Continental Shelf took place in a circle six nautical miles around the New York Bight dump site.

In 1973-74 the press started referring to the Bight as a "dead sea," predicting that sludge would soon be washing on the beaches and advised of potential serious health hazards. While balanced scientific opinion was available, the public did not have ready access to it. As a result, the public's immediate view of policy, research, and monitoring priorities was somewhat distorted by lack of information. The National Environmental Policy Act resulted in a planning process which put priorities and alternatives into perspective and contributed to the present, more reasonable regulatory/research/monitoring environment. As a result, EPA has now stated that "there is no present evidence that dumping at New York Bight has caused any damage to public health, or that such damage is likely to occur before the dumping of sewage sludge ends in 1981."

The point of this extended example is that here we have a case history of three quarters of a century of known marine pollution in which <u>integrated planning</u> of regulatory actions, monitoring, and research did not occur until after a very bad situation was created. Given the sophistication of contemporary technology and the speed with which development can take place, it is crucial that planning be put on the <u>front end</u> of further marine pollution activities rather than the hind end. That is why the formulation of this five-year plan with associated setting of priorities is of such importance.

Even with ocean dumping highly regulated and already the object of extensive monitoring and research activities, the need for future research and monitoring programs is still very great. The New York Bight itself will provide fertile grounds for decades of fruitful research on microorganism survival, heavy-metal dynamics, and ecological processes. The alternatives to dumping, principally incineration, pyrolysis, surface land application and landfill disposal all have substantial environmental effects which will have to receive close and immediate examination.

The relationship among policy, research, development, and monitoring in our efforts to protect the marine environment will have to continue to remain closely linked.

I have tried to encourage you to be innovative in your task of the next several days. If you are not, no doubt you will produce a plan which will be perceived as satisfactory and adequate, but one which--unfortunately--will not be able to stand up to the unpredictability of future change in public policy and scientific knowledge.

Assume this Workshop took place 10 years ago. Would you have included as a priority item an early-warning monitoring capability which would have identified the Kepone problem sooner? How would the marine PCB problem have fared at such a workshop 10 years ago? What topics would have been identified as research or monitoring priorities associated with sludge dumping?

You face a similar hazard now. Although it is more comfortable to deal with the problems that have been identified and studied <u>up to now</u>, the plan you are contributing to is a <u>plan for the future</u>.

Concerning such effort, I extend to you our gratitude for your participation and our best wishes for your success.

Thank you.

SECTION 4

ENERGY GENERATING SYSTEMS

PANEL REPORT

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INTRODUCTION

The Energy Generating Systems Panel agreed that not only dominant energy technologies, but those not yet operational on a significant scale should be discussed. Environmental assessment performed prior to the widespread application of an energy technology may avoid undesirable consequences, and indeed, may provide grounds for a decision not to apply the technology itself in any form.

The marine environment is a source of energy that can be transformed into electricity through four basic means:

- Exploitation of offshore oil and gas
- Exploitation of kinetic energy
- Exploitation of potential energy
- Exploitation of marine thermal energy differences

Offshore oil and gas exploitation will be considered in the marine minerals section. Exploitation of kinetic energy is carried out through generators driven by ocean currents, tidal currents, or waves. Exploitation of potential energy covers three basic methodologies: storage of water pressure head in natural embayments with extreme tidal range, pumped storage of water using power generated during off-peak loads, and exploitation of the salinity gradient. The latter is seen as the largest potential energy source in the oceans, but extraction technology is the least developed. Problems with this technology include the potential for serious pollution from salt concentrations (brines).

Exploitation of marine thermal energy differences refers to the ocean thermal energy conversion (OTEC) systems for electrical or chemical energy production (e.g., hydrogen).

The marine environment is also a source of fuels for energy generating systems. One such fuel source involves marine biomass cultivation, either for electricity or chemical fuel (methane). The burning of marine biomass for conversion to electricity is not practical or efficient; fuels may, however, be produced from the biomass (electricity is not directly produced in any sense). Another source of energy is marine or coastal geothermal systems. The marine environment also serves as a sink for waste heat in conjunction with cooling systems for electrical power plants.

DESCRIPTION OF ENERGY GENERATING SYSTEMS

Level and Location of Activity

Marine thermal gradient systems such as OTEC would utilize the temperature difference between warm surface water and cold, deeper waters, principally in tropical areas. The temperature difference would be used to vaporize a working fluid (e.g., propane or ammonia) which would be condensed back to fluid (closed cycle) after being used to drive power plant turbines. It is noted here that the kind and quality of pollution are very different between systems, i.e., closed versus open OTEC systems. Consideration of alternative cycles is significant in determining the level and location of activity. Remaining technological and economic problems and uncertain environmental consequences have resulted in a cautious, exploratory development program.

Marine kinetic systems include various schemes to harness ocean currents and waves. Because the vast energy of fluid motion is not concentrated in limited areas, there is a problem of scale for conversion technology. For example, if the energy from waves is harnessed, hundreds or thousands of discrete conversion units may be required to produce enough power to compete with existing energy sources.

Marine potential energy systems involve coastal embayments where the tidal range is usually great. These areas provide opportunities for the use of tidal power to fill a dam mechanism analogous to a hydroelectric reservoir on a river. The only operational systems are Rance Estuary in France and Kislaya Bay in the USSR. Potential sites in the United States are Passamaquoddy Bay in Maine and Cook Inlet in Alaska. High technological costs and distance from large energy markets indicate that tidal power systems are only local substitutions for present technologies of power production. Other marine energy systems of potential use include salinity gradients and pumped storage.

Other energy production systems associated with the marine environment are at conceptual stages of development. Marine biomass fuels production systems, geothermal systems (with brine effluents in coastal waters) and nuclear fusion systems have been proposed. Although these systems are not likely to contribute to energy supplies significantly in the foreseeable future, they should be considered in order to determine their potential polluting characteristics should they be utilized.

Approximately two-thirds of the 774 fossil-fueled and 65 nuclear-fueled power plants generate electrical power in United States coastal areas. Over 100 additional plants (fossil and nuclear) are expected in U.S. coastal counties between 1978 and 1995. Inherent to steam turbine generating technology is the requirement for substantial plant cooling capacity and the attendant loss of unrecovered energy during transformation of heat to electricity (always in excess of 60 percent). Effluent heating during the cooling process may range from a few degrees to 20° Centigrade, depending upon plant technology, site and other factors.

Offshore electrical power generating plants (nuclear and fossil fuel), either fixed or floating, have been considered feasible enough to warrant advanced development commitments by utilities and manufacturers because onshore sites adjacent to energy consumption centers are frequently unsuitable. Offshore floating nuclear power plants may be operational by 1990, and as many as 10 may be operating by the end of the century. Advantages include relatively large supplies of available marine cooling water.

<u>Value and Importance of Activity</u>

It is difficult to project U.S. demand and supply of total energy because of the economic, technological and social factors affecting energy consumption. Recent trends of increasing absolute and per capita energy demand are likely to continue into the foreseeable future (albeit possibly at lesser rates of increase). The total U.S. energy consumption (including oil, gas and other energy forms) in 1977 subdivides as follows:

residential and commercial	19%
industrial and miscellaneous	25%
transportation	26%
electricity	30%

Electrical energy is the only usable form for many socially-valued energy applications. Other energy sources could be substituted for electricity; however, it should not be presumed that all present electrical energy applications will continue.

By any index, the generation of electricity produces significant benefits for society. Fossil- and nuclear-fueled plants produce 75 percent of the total supply of electricity in the U.S. (1977). Electricity is consumed as follows:

residential	33%
commercial	23%
industrial	40%
other	4%

Capital requirements for energy technologies from 1978 through 1995 are approximately $209 billion for electrical generating plants (fossil and nuclear) as compared to $156 billion for all other oil, gas, coal and new sources combined. Inherent limitations to the efficiency of electrical transmission technology and the unabated tendency for population to aggregate in coastal areas will probably result in additional dependence upon power plants in coastal sites. As other social needs compete for coastal space and resources, reconciling energy plant needs in the coastal zone will become increasingly difficult.

<u>Environmental Quality Concerns</u>

In a sense, each generating system associated with the marine environment represents unique technological and site characteristics. It is possible, however, to identify categories of environmental alteration grouped under the broad heading of: (1) thermal effects, (2) other chemical effects, (3) other physical effects, and (4) biological effects.

Thermal effects resulting from unavoidable discharge of unrecoverable heat during plant or ocean cooling from heat extraction are difficult to assess. They may be beneficial or deleterious depending on the extent or the level of change they create. Warmer water increases fish metabolism and stresses life processes. It may, therefore, lead to lethal or sublethal consequences (particularly during early life stages). Thermal stress on life functions is often exacerbated by chemical pollutants contained in effluents. An increase in water temperature may result in an ecological shift in species composition, e.g., a proliferation of pests. Extreme temperature changes have caused heat kills and cold kills of marine animals at several power plants.

Chemical effects may result from any of the following:

- Use of biocides to reduce system fouling
- Low-level irradiation and chemical changes in nuclear systems
- Chemical discharges from geothermal systems
- Release of dissolved gases (especially CO_2) in open-cycle OTEC

Physical effects include:

- Damage to organisms entrained in cooling system by physical barriers, strainers, filters, etc
- Localized scouring of benthic habitats from cooling system flows
- Altered sediment transport regime
- Altered biological effects due to large pressure changes
- Local development of secondary circulation patterns

Biological effects include changes in biological community structure because of thermal, chemical, or physical effects. Different and less desired biological populations may dominate the new ecological equilibrium. At the intake, plants and animals also are harmed by being drawn into the cooling water system or otherwise removed from the ecological community.

National Decision Processes Related to the Activity

Because of the scale, critical importance and potential hazards of energy production systems, complex public controls are applied to all phases of the establishment and operation of these systems. Controls are imposed at the federal, state and local levels. The variety of purposes includes utility pricing, land use, public safety, occupational health, environmental protection and public utility organization.

A number of Federal agencies have authority over electrical plants in coastal areas. The Environmental Protection Agency (EPA), under the Federal Water Pollution Control Act, regulates the intake and effluents of plants by a permit process [National Pollutant Discharge Elimination System (NPDES)] based upon technological performance standards [e.g., Best Available Technology (BAT)]. The Nuclear Regulatory Commission (NRC) controls nuclear plant siting from the standpoint of public safety. The U.S. Department of Energy (DOE) considers energy planning, technological improvement and environmental protection aspects of electrical power generating systems and promotes new technologies. Other federal agencies regulate business aspects of the electrical industry which have indirect effects upon where power is generated in the coastal zone.

Implementation of Federal regulatory and administrative authority requires broad information about risks, effects, costs, benefits and unintended consequences. Pervasive uncertainties, lack of available information, and the inherent problem of weighing incommensurable factors complicate decisions. Public policy and regulatory processes at the Federal level involve complex interactions among the Executive, Legislative and Judicial branches, as well as a spate of public-interest groups and private interests. Timely availability of information and evidence may contribute to the quality, effectiveness and legitimacy of the whole decision process.

Limiting Factors

Limiting factors have been organized into three major categories. The first is specific to steam turbine power plants; the second, to OTEC; and the third, to other systems. Within each category, scientific, technological, economic and sociological factors are enumerated.

Steam Turbine Power Plants--

Scientific limiting factors--The Federal Water Pollution Control Act (P.L. 92-500) specifies that permit applicants "assure the protection and propagation of a balanced indigenous population of fish, shellfish and wildlife in and on the body of water." Because features of each plant site are unique, it is difficult to predict environmental consequences of alternative effluent control technologies with confidence. Improved knowledge from retrospective study of existing facilities and modeling of ecological risk may help to reduce uncertainty. Knowledge of the actual extent and character of effects depends upon more fundamental study of causal relationships and general ecosystem behavior under particular stresses (heat, contaminants, etc.) It is often difficult to discriminate between natural and man-caused changes.

Technological limiting factors--P.L. 92-500 sets technological standards for cooling system performance. High costs and the characteristics of financing cause a conservative bias against technological innovation in power plant systems. Technological problems include:

- Entrapment, impingement and entrainment of organisms
- Biocide poisoning
- Heat and cold and nitrogen kills
- Scouring of bottom life

Technological solutions include intake and outfall diffuser innovation and more fundamental changes in design. The uncertain performance and reliability of new technologies are also limiting factors.

Economic limiting factors--These include deficiencies in cost-benefit and risk-benefit analytical methods. Among these are problems of non-economically valued parameters and incommensurables, and an insufficient account of the financial considerations necessary to capitalize expensive facilities which often require investments a decade or more prior to system operation. Reassessment of economic regulation policy for electrical utilities is needed in the light of adverse technological and siting implications. For example, antitrust provisions may preclude regional power system development that could eliminate the need for marginal sites in certain jurisdictions. Another limiting factor lies in economic uncertainty, both domestic and foreign.

Sociological limiting factors--These may include:

- Public perception of the risks of fossil- and nuclear-fueled power generating technologies
- Public reaction to power pricing consequences of environmentally beneficial technologies
- Basic public attitudes toward power consumption and the amount of time necessary for attitudinal change
- "Boom-town" effect during system construction

OTEC--

Scientific limiting factors--These may include:

- Ecological, oceanographic and meteorological effects of redistribution of great quantities of ocean water (10 times as much as conventional power plants)
- Effects of chlorine discharged as a biocide
- Effects of discharges of large quantities of nutrient-rich, deep water into near-surface layers
- CO_2 discharge for open-cycle OTEC

Technological limiting factors--These include consideration of large quantities of water necessary for system operation and the antifouling methods needed to preserve the performance of the heat exchangers.

Economic limiting factors--These include the cost implications of alternative OTEC systems, associated controls to "solve" problems, as well as the inadequate basis for cost/benefit and risk/benefit accounting.

Sociological limiting factors--These include:

- Possible conflict with other ocean uses
- Perceived system vulnerability because of offshore site
- Potential socio-legal international questions and problems

Other Energy Generating Systems--

The limiting factor for these systems involve their experimental nature and the fact that knowledge of their ultimate utility is generally lacking. The systems considered include:

- Biomass
- Coastal geothermal
- Tides
- Waves
- Currents
- Salinity gradient
- Satellite power system (SPS)

Of these six, biomass and coastal geothermal would presently appear to have the greatest potential application in the foreseeable future.

CONCLUSIONS AND RECOMMENDATIONS

Identification of Energy Technologies Associated With the Marine Environment

The Panel discussed the various energy technologies associated with the marine environment and agreed upon the following characterizations:

A. Technologies ranked by descending order in terms of the immediacy of their application to the marine environment.

1. Nuclear-fueled plants
2. Fossil-fueled plants
3. Geothermal plants
4. Pumped storage systems
5. Ocean Thermal Energy Conversion (OTEC)
6. Marine biomass systems
7. Wave systems
8. Tidal systems
9. Current systems
10. Salinity gradient systems
11. Satellite power systems (SPS)

Note: In listing technologies in approximate order of immediacy of application to the marine environment, the Panel wished to emphasize that the technologies ranked fifth to eleventh would probably only be feasible in the distant future. On the other hand, the first four technologies seemed relatively more certain to be applied.

B. Technologies ranked by descending order in terms of their potential environmental impact.

1. Satellite power systems (SPS)
2. Fossil-fueled plants

3. OTEC
4. Nuclear-fueled plants
5. Geothermal plants
6. Salinity gradient systems
7. Marine biomass systems
8. Tidal systems
9. Wave systems
10. Pumped storage systems
11. Current systems

Criteria--

The Panel agreed that explicit criteria would be prerequisites for any consideration of priorities. The following criteria were identified as the basis for an assessment of priorities for research, development and monitoring in marine energy:

- Immediacy of technological application (1 = least immediate; 7 = most immediate)
- Scale of probable environmental impact (1 = least impact; 7 = greatest impact)
- Level of existing knowledge pertaining to pollution effects (1 = least knowledge requirement; 7 = greatest knowledge requirement

For the last criterion, the Panel considered several elements to be important. However, it was unable to differentiate among those elements in the specific cases of information needs. For the record, the Panel requested that the following elements of knowledge be identified:

- Data base
- Scientific assessment
- Predictive modeling
- Monitoring capability.

Assessment of Priorities--

The Panel assessed the priority information needs using the following procedure:

- Each Panel member rated each information need in terms of the three criteria on an ascending scale of 1 to 7
- For each information need, the raw criterion score was weighted 40 percent for immediacy (criterion 1); 40 percent for environmental impact (criterion 2); and 20 percent for knowledge level (criterion 3)
- The average aggregate score for each information need was determined from the responses of each Panel member

Summary of Priority Assessment--

The 55 information needs which the Panel ranked in priority order are listed in the following table. Thirteen needs were considered to warrant highest priority; 20 needs, medium priority; and 22 needs, lowest priority. The actual aggregate score for each need is reported for further reference.

NEEDS AND PRIORITIES FOR OCEAN POLLUTION RESEARCH AND DEVELOPMENT AND MONITORING

Rank	Score (1-7)	Information Need
1	6.7	Develop mechanisms for evaluating environmental stresses based on multiple activity assumptions measuring the aggregate of impacts of combined activities within a single region. Identify those activities which may be best combined for enhanced environmental, economic or social attributes.
2	6.7	Develop predictive techniques for environmental forecasting. This need be done for both stressed and unstressed natural systems, to lessen lead-time study requirements and to provide objective criteria for decision-making. Note that a great deal of additional knowledge of all biological systems is required for this to be achieved.
3	6.5	Determine the potential ecological and health impacts of large-scale accidental releases of contaminants from energy generating facilities.
4	6.5	Develop ecosystem monitoring techniques for evaluating environmental quality stability.
5	6.3	Determine the hydrothermal, biocidal and radioactive pollutant discharge effects of coastal zone and offshore nuclear power plants.
6	6.0	Measure the pollution effects of biocides (chlorination products) and chemical effluents from offshore and coastal-zone located fossil fuel power plants.
7	6.0	Determine the relationships and reactions between selected environmental parameters and discrete population elements (bioindicators) as a means of measuring the health of an ecosystem.
8	6.0	Determine mechanisms of radionuclide assimilation, accumulation and excretion in exposed biota.
9	5.9	Evaluate the comprehensive environmental and other effects resulting from temperature changes induced by 10 years operation of many OTEC plants (100-100KW plants) in the Gulf of Mexico. Estimate temperature increase in the Gulf of Mexico basin.

Rank	Score (1-7)	Information Need
10	5.8	Measure the increased impact of thermal stress when exacerbated by addition of effluent chemical pollutants from an offshore nuclear power plant (synergistic effects).
11	5.7	Determine the pollutant potential for geothermal energy systems, including such variables as brine types and content, temperature variation, heavy metal concentrations and corrosion potential, for inner shelf (open circulation), estuarine (restricted circulation) and coastal zone locations.
12	5.6	Determine the alterations to sediment transport, current distribution, and biotic impact anticipated by constructing an offshore fossil- or nuclear-fuel power plant, including the transmission cable subsystem.
13	5.6	Measure the environmental stresses from both fossil-fuel and nuclear coastal-zone and offshore located power plants.
14	5.5	Determine the environmental impact of the high volume of water flow associated with OTEC, noting that this flow level is several orders of magnitude greater than that for conventional plants.
15	5.5	Assess geologic and oceanographic characteristics of proposed energy generation sites.
16	5.5	Develop criteria for energy generation site selection to ensure adequate consideration for environment, health, safety and socio-economic aspects.
17	5.3	Determine the environmental impact of a major marine biomass farming and processing activity (use site-specific cases).
18	5.2	Determine the pollutant effect of antifouling biocides on biota.
19	5.2	Determine the effects of increased biologic productivity resulting from nutrient enrichment due to OTEC transfer of deep water to surface layers.
20	5.2	Determine the overall environmental effects of a chemical production OTEC plant (as opposed to electric transmission plant). (Note that limits for electric transmission are approximately 20 miles for AC and 150 miles for DC, due to cable transmission limitations.)
21	5.2	Assess and predict effects of weather on proposed facilities, including wave effects under severe storm conditions.
22	5.1	Determine and evaluate the complex estuarine/oceanic hydraulic relationship as a means to identify possible sites for ocean energy structure emplacement (siting). Use this knowledge to identify "minimum obstruction siting" criteria.
23	5.1	Measure and evaluate the pollutant potential created by using antifouling additives, materials, coatings, etc. on OTEC and other offshore energy structures.
24	5.1	Determine the effects of continuous use of biocides as antifouling agents for OTEC heat exchanger.
25	5.1	Evaluate the pollutant potential of gas production in open-cycle OTEC; determine the probable effects of degassing.
26	5.1	Measure the alteration and modification of biotic processes and functions (at a sublethal level) within the effluent stream (hydrothermal plume) of a nuclear offshore power plant.
27	4.9	Evaluate the pollution potential of leakage of OTEC contained chemicals (note very large surface area of heat exchanger and related increased leak potential because of it).
28	4.9	Evaluate the safety problems associated with the location of an offshore nuclear- or fossil-fuel power plant from the standpoint of vessel navigation and collision potential.
29	4.9	Measure the overall environment effects of thermal shock resulting from an offshore nuclear plant thermal plume.
30	4.7	Determine the environmental problems associated with eutrophication in biomass conversion processes.
31	4.6	Measure and evaluate ocean/atmospheric interaction processes to provide minimal disruption criteria for ocean and estuary energy structure emplacement.

Rank	Score (1-7)	Information Need
32	4.6	Given that the chemical OTEC plant will produce ammonia and hydrogen, and may also produce aluminum and "Sea Chemical," determine the environmental effects of this production and release or treatment of the associated pollutants that would accompany it.
33	4.6	Enumerate and evaluate environmental issues related to the "chemical production plant" aspects of an ammonia/hydrogen producing OTEC plant, stressing problems of storage and transportation of the products.
34	4.4	Determine and measure the broad scale environmental consequences of oceanic current speed change and configuration alteration caused by ocean turbine structures in offshore locations.
35	4.4	Evaluate mechanisms for energy recovery over extensive areas of coastline, as would be necessary using wave movement for power generation to determine optimal minimum space requirements and polluting characteristics.
36	4.4	Determine the effects of local (microclimatic) weather alterations induced by hydrothermal and other effects of an offshore nuclear- or fossil-fuel power plant (evaluate probable fog development conditions in particular).
37	4.3	Measure and evaluate the results of restricted flushing capability due to emplacement of an ocean turbine system (tidal dam) in an estuary.
38	4.3	Evaluate the international aspects of OTEC structures located beyond U.S. territorial sea.
39	4.1	Determine the environmental impacts (space, wave modification, influence on air-sea interaction processes, navigational hazard, etc.) of a satellite power system antenna field at sea (marine-based solar energy transformation system).
40	4.0	Evaluate the navigation hazard of offshore energy generating structures.
41	3.9	Measure the effect on the marine biota (pelagic) due to entrapment/impingement/containment properties of OTEC.
42	3.9	Evaluate the pollution characteristics and costs of cable transmission of electricity from OTEC offshore to onshore power grid.
43	3.8	Determine the effects of "wave energy" power generating devices on coastal sediment transport due to altered wave-field relationships.
44	3.8	Determine the environmental effects of circulation restriction/alteration resulting from transport and storage requirements of potential energy utilization
45	3.7	Identify the hazards to navigation resulting from ocean or estuarine turbine (tidal dam) or other structure emplacement.
46	3.6	Determine the probable altered microclimatic characteristics resulting from changed current meander patterns and distribution, including other eddies and gyres produced by ocean turbine structures (site-specific).
47	3.6	Measure the environmental effects of water impoundment (pumped energy applications) and release.
48	3.6	Determine the environmental effects of effluent discharge resulting from salinity gradient energy production.
49	3.5	Determine the environmental effects of releasing the effluents and contaminants resulting from membrane cleaning (salinity gradient process).
50	3.2	Evaluate the legal, social and economic effects (problems) of ocean turbine structures located in international waters.
51	3.1	Determine the pollutant effect on biota of lubricants used in ocean turbines.
52	3.0	Determine the "reef" effect of ocean turbines and associated (similar) structures.
53	2.9	Determine the negative aesthetic aspects of OTEC and other offshore energy facilities (both shore visible and shore non-visible).
54	2.8	Evaluate quantitatively the effects of ocean turbines on the entrapment and impingement of pelagic organisms

Rank	Score (1-7)	Information Need
55	2.7	Determine the impact of the "bow wave" effect produced by alteration of the general wave pattern as a result of ocean turbine or other structure emplacement.

SECTION 5

LIVING RESOURCES

PANEL REPORT

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INTRODUCTION

A developing world is going to change the marine environment. It will not be possible in the future to regulate or manage for a zero impact. The need is to develop utilization programs which are the least disruptive to the coastal and ocean areas and afford optimum protection for the living resources and for mankind.

Research and monitoring information must be made available and useful to those who make decisions about the marine environment. Adverse effects on resources are of particular concern to Regional Fishery Management Councils (in management of fish stocks); to the U.S. Army Corps of Engineers (especially in matters concerning dredge spoil disposal); to the U.S. Environmental Protection Agency (especially in developing and enforcing regulations concerned with ocean disposal of wastes); to the Federal Food and Drug Administration (in matters of chemical contamination of edible products and shellfish sanitation); and to the states (in managing their territorial waters).

General Approaches to the Effects of Pollution on Marine Resources

The term pollution describes a wide variety of interacting gross and subtle human-induced alterations in the marine environment. Unravelling this complexity requires sophisticated thinking and research. Since the sheer numbers of pollutants and environmental factors make investigation of all compounds and all sites impractical; a generic approach must be used. Principles should be developed that enhance an understanding of effects from different types of pollutants under different environmental conditions. Based on these considerations, three broad areas of research should proceed simultaneously in an integrated, complementary way:

- Description and quantification of critical, functional components of undisturbed and perturbed ecosystems (e.g., physical parameters, chemical components, population, and tropic levels) in estuaries, the coastal zone, and continental shelf
- Measurement of rates and interactions associated with processes and fluxes within individual organisms and in major ecosystems; for example, changes in metabolism of normal and affected organisms, and the transfer of chemical contaminants through food webs and relationships between trophic levels such as primary, secondary, and tertiary productivity
- Determination and evaluation of effects of changes--both acute and chronic--on components, processes and fluxes that

constitute significant alterations in organisms and ecosystems; for example, normal fluctuations resulting from variations in annual recruitment into fish populations, reduced fecundity of fishes caused by chlorinated hydrocarbons and the possible induction of cellular anomalies in fishes exposed to environmental teratogens, mutagens or carcinogens

To achieve the desired interaction among research components, continuous, broad-scale, interdisciplinary, resource and environmental monitoring should be carried out in harmony with field and experimental laboratory programs aimed at elucidating processes and effects. The latter research should focus on problems identified through monitoring. It should stress identification of contaminants that produce the most severe effects, at environmental concentrations, on resource species and food webs. Conversely, insights from laboratory studies should be verified in the field and applied to understanding events in polluted coastal and estuarine environments.

Because marine environments often contain complex mixtures of pollutants and naturally-occurring chemicals, special consideration should be given to the impact of multiple components on marine organisms and ecosystems; i.e., antagonistic and synergistic effects.

Seldom are management decisions regarding the effects of environmental pollution based on unequivocal evidence; rather, balanced judgments are made (or should be made) after the available scientific evidence is considered. Research which provides scientifically credible and legally viable data and recommendations that make for good management decisions should be conducted. Short-term cosmetic approaches are inadequate to preserve the nation's resources and are invalid in light of the complexities inherent in both normal and polluted marine systems. Although short-term progress can be made in some cases with little effort, our understanding of the chronic aspects of pollution will only be realized through a substantial and continuous national program.

SPECIFIC PROGRAM RECOMMENDATIONS

Pollution-oriented research should be closely coordinated and interactive with monitoring. Decisions on the environment should be based on knowledge of existing levels of contamination, their rates of increase or decrease, and their effects on organisms and ecosystems under different environmental conditions.

In developing a research and development and monitoring program, it is recommended that priority be assigned to identified pollutants as follows:

1. Organics, especially synthetics
2. Metals
3. Halogen products
4. Fossil fuel
5. Radionuclides
6. Microorganisms
7. Dredge and waste disposal
8. Biostimulants
9. Litter

Monitoring

A balanced, symbiotic relationship must exist between the monitoring and experimental phases of the program. Monitoring programs should be directed toward understanding changes in undisturbed and perturbed biological systems.

Projects should include qualitative and quantitative analyses of contaminants, their chemical states and macromolecular complexes. Competence in analytical chemistry should be expanded to permit the broadest possible perspective on components of pollutant systems. It is essential that we distinguish between the presence of a material, the form that the material takes in the environment, its biotransformations, and most significantly, its biological impact. Presence does not imply harm in every instance. Attention should also focus on increasing our breadth of perspective of environments under our jurisdiction by establishing indices of pathological, behavioral, physiological, biochemical, genetic, and immunological changes in normal and altered systems. A major objective of monitoring programs should be to establish relationships between biological changes and pollutant profiles and to minimize the areas adversely affected.

Because limits have to be established in the overall monitoring effort, the choice of sites should be based on certain, carefully-conceived priorities; for example, areas of planned changes in human activities that may influence living marine resources, areas that have a history of continuous monitoring, areas where investigations of pollution problems are (or have been) a major activity, and areas of important resource production.

Rates and Interactions

The study of rates, processes, and fluxes involves more than simply identifying and quantifying contaminant concentrations; the information derived is critical to an understanding of normal and human-induced alterations in the marine environment. Decisions about priorities in researching the impacts of rates, processes, and fluxes should be based on:

- The importance of the resources affected

- The toxicity and persistence of the pollutants
- The potential for expanding scientific understanding of marine systems through the acquisition of generic information
- The public health significance of natural populations of living organisms as early warning systems sensitive to disturbance by pollutant

Once decisions have been made about groups of contaminants to be studied, their precise chemical form becomes significant because toxic properties are intimately associated with molecular structure and the formation of chemical complexes with a variety of matrices. Particular emphasis should be placed on interactions among multiple pollutants on pollutant interactions with components of biological systems. Despite its importance, this area has been neglected. Conversion products of contaminants arising from chemical and biological processes are sometimes more toxic than parent compounds. A significant emphasis must therefore be placed on determining the structure, concentration, rates of conversion, persistence, bioavailability and biological impacts of them.

The transfer of pollutants, their degradation products through food webs, and their interactive effects with natural factors in the environment (e.g., nutrients, salinity, temperature) should also be studied, as should physical concentration systems created by water current patterns. The environmental impacts from transport, recycling or immobilization of pollutants (e.g., trapping in sediments), together with their accumulations in the biota, are important processes to include when alterations in organisms and ecosystems are assessed.

Descriptive and mathematical ecological models relating to physical, chemical and biological processes are useful in describing and predicting pollutant effects. These models must rely on real field operations. They currently exist, or are being developed, and they are constructed at various levels of complexity; for example, biological models may include processes at the organism, population, community and ecosystem levels. Some of these models have already been used to describe and predict effects of environmental alterations and population. Others have potential if further developed. Modeling, as described, should be considered in the overall assessment of pollutant effects in the marine environment. It is to be used as one tool to aid the ecologist in better understanding ecosystems.

Effects

A major responsibility should be to understand how pollution affects fisheries and their supportive ecosystems. This goal can only be reached if high priority is given to the study of biological effects. The broadest, most meaningful set of indicative criteria must be employed if balanced judgments are to be made about alterations in marine biota. Acute and chronic effects should be evaluated in the laboratory and in field studies using broad, interdisciplinary research on life stages of fish, invertebrates, and organisms in their food web.

Some obvious sublethal effects include:

- Physiological and biochemical changes resulting or associated with reduced growth or inhibition of spawning
- Behavioral anomalies often influenced by changes in sensory systems
- Pathological alterations in tissues that suggest changes in function(s) of organs or viability of animals
- Genetic changes

Because chronic effects (e.g., neoplasia) often have long, latent periods, every effort must be made to identify early signs of damage. Suggested approaches include examinations for preneoplastic changes of tissues, for ultrastructural alterations of cells, for damage to DNA, and for alterations in the competence of immune systems.

Field experiments are bridges between the laboratory and contaminated environments. With natural systems, there are obvious difficulties in limiting the numbers of experimental variables so that effects can be understood. Thus, field studies must operate in concert with laboratory studies that identify and pinpoint indices of perturbation. Pathology, behavioral biology, and physiology are particularly useful for assessing damage in the context of the field studies.

Alterations in ecosystems are particularly difficult to identify and evaluate. Primary production, reflecting the lowest trophic level for marine systems in the upper water column, can be affected by pollutants. Also, changes in abundance of organisms at any trophic level may affect abundance at other levels, and some species (as well as some larger phylogenetic groups, such as the crustacea and pleuronectids), are more sensitive than others to certain classes of contaminants.

GENERAL INFORMATION NEEDS

Living resources are menaced most intensively by the following processes in the environment:

- Long-lived, synthetic, biologically-active organic substances
- Heavy metals
- Power plant cooling water
- Sludge discharges
- Loss of habitat

Additional information is needed on the present distribution , nature, and impacts of synthetic organic chemicals as well as the anthropogenic introduction of heavy metals.

There are also a number of public health elements in these recommendations.

At present, sludge discharges or dumping are a major problem for the health, integrity and productivity of coastal living resources.

Accidental oil and chemical spills and discharges threaten living marine resources. The impact, fate and longevity of chemical residues in marine waters deserves more attention. Protection, rather than cleanup, must be the approach. However, the impact of cleanup technology on the living resources must be studied, since we do not know if physical removal is the best protocol in all instances. We must develop ecologically valid recommendations based on actual field data.

Additive and synergistic impacts where multiple wastes, include cooling waters from power plants, are discharged is a growing problem because of increasing population and increasing industrial and transportation use in the coastal zone.

Monitoring the impacts of pollutants in marine waters must include comparisons of reference populations of marine organisms in unimpacted areas with those found in areas where waste is discharged. Strategies and priorities of approaches to such studies deserve immediate attention.

Trends in deterioration of quality and productivity of land renewable resources, as these relate to marine resources, need evaluation. Among the subjects to be considered are:

- Loss of soil
- Loss of soil nutrients
- Increase in atmospheric CO_2 concentration
- Increases in air pollution burden (SO_2, NO_x, particulates, hydrocarbons)
- Shoreline modifications resulting in loss of habitat; e.g., loss of wetlands, and increases in turbidity and sedimentation

The economic, commercial and recreational importance of preserving and enhancing production of living marine resources should be considered. Whereas the U.S. once exported fish and fisheries products, it now imports on the order of 60 percent of its fishery products. Protection and enhancement of renewable marine resources may provide additional employment opportunities as well as improve this aspect of the balance of payments problem. Consuming high-quality low-fat, low-cholesterol seafood may prove to be a significant public health benefit.

Improvements in the effectiveness of source control of environmentally hazardous matrials before they are released to the environment is urgently required. Strategies and techniques to enforce this provision of waste water quality control deserve highest priority. Too many treatment plants suffer upsets, water reclamation programs are disrupted, and pollution events result from excessive loads of hazardous materials arriving in treatment plants.

Increasing use of coastal waters for cooling purposes presents a problem. In some areas, investments in operation and maintenance required to restore and maintain receiving water quality in treatment plants may be negated when these same receiving waters are used for cooling purposes. This is especially critical where reproductively isolated populations or organisms may be found and when the larval and juvenile stages of local fauna may be adversely affected by passing through a power plant.

Many coastal water masses appear to have low rates of turnover and are thus susceptible to being saturated with waste discharges. Waste discharges should be controlled so that the critical substances or impacts (e.g., thermal) are added at a rate less than that of the rate of turnover of the receiving waters.

Alternative uses, such as recycling of wastes now discharged to the ocean, especially those of sewage sludge, deserve urgent attention.

The above recommendations are offered in the context of improving and protecting the quality of coastal waters. They are also meant to assure the productivity of renewable natural resources for commercial and recreational fisheries and to protect public health.

Some of the information recommended above has been collected; in other cases, data need to be gathered, organized systematically, and analyzed to discern trends. Techniques and technology are available to accomplish most of these tasks. Managerial strategies, enforcement, monitoring and implementation may sometimes be very difficult; for example, as it is with sludge disposal on land. Also, when a receiving water is saturated or used to capacity, as with thermal discharge for cooling purposes, denying expanded use of such waters may be very difficult.

Protection of coastal waters from pollutants and excessive use as well as land-use restrictions for habitat protection may represent massive expenditures of public funds and an enormous commitment of time and labor. It could all be misspent if a massive accident such as a huge oil spill occurred. Every means available should be taken to prevent such an accident. At present, control over the movement of hazardous cargoes is inadequate in the world's coastal waters. Means for achieving better control of these movements is urgently needed. At a minimum, any cargo or tanker vessel approaching within 50 miles of the coastline or within 50 miles of a known hazard to navigation should be given navigational assistance which parallels bridge control of the vessel. Vessels approaching within six miles of restricted channels and bays should be subject to port traffic control in addition to bridge control. The expenses and damages now occurring, together with the scale of damage resulting from accidental collisions or grounds, are massive. The unregulated movement of vessels of commerce in the coastal waters of the U.S.A. should, therefore, not be permitted to continue.

Information on the occurrence and distribution of hazardous materials in the marine environment can be useful to state and federal water pollution control agencies , wildlife management agencies, public health agencies, marine biologists, fisheries operations, and the public.

Alternatives to marine disposal of sludge may be useful in alternative energy production, aquaculture, agriculture, silviculture, and horticulture.

Problems of once-through cooling water passage in power plant operation and limitations of receiving water capacity are important to marine biologists and agencies involved in power plant siting and water quality control.

Control of commercial vessels is important to the vessel operators, the U.S. Coast Guard, oil spill cleanup contractors, wildlife protection agencies, fishing operators, and coastal recreational interests.

SPECIFIC PROBLEMS AND RESEARCH NEEDS

Fisheries Waste Processing

Besides possible disease transmission, fisheries wastes have only one currently identified problem--adequate dilution. If facilities have appropriate outfalls to allow proper dilution, they should not be required to waste money and energy for sophisticated waste treatment.

If facilities are poorly sited, low-cost treatment methods are suggested as a research need. Pollution from these sources is a function of organic loading and recycling of nutrients and does not involve toxic and bioaccumulative substances.

Disease Transmission

Neoplasia in shellfish and fishes in the Great Lakes and coastal areas may, in some cases, have a viral etiology. Pollutants may aggravate the prevalence and severity of the disease. In addition, contaminated materials released from processing facilities may aid in transmitting the infection. Bacterial, fungal, and parasitic diseases may be supported by processing facilities.

Fish processing wastes may also result in the concentration and spread of anisakiasis, an infection of nematodes, in fishes. Humans who eat these fish may become infected (Sinderman, C.J. Principal Diseases of Marine Fish and Shellfish, Academic Press, New York, 1969).

Users--
The processing facilities should know if this exists, so that it can be controlled. This information should be disseminated to the user group if it becomes a problem (Information Exchange and Transfer).

Time--
This program can be designed, conducted, and completed in three years.

Current Research--
Research currently focuses only on the infected organisms and not on waste treatment.

By-Product Development of Useful Substances from Present Processing Waste Loads

Where natural environmental effects, i.e., inadequate tidal flush, do not permit ease of disposal, it would be prudent to investigate the possible by-products that would be economically derived from processing wastes. Closed loop utilization could result in water and energy conservation as well. Little, if any, data or research exist in this area.

Time--
This program would take five years.

User--
Seafood processing industry could use it if it were economically viable, i.e., if a minimum return could meet expense.

Screening Marine Ecosystems for Unknown Effects: A Tiered Approach

It is impossible to predict all environmental disasters. Therefore, a low-cost environmental "watch" for pending disasters is recommended. This could be a series of regular benthic collections for key species. Southern California Coastal Water Research Project (SCCWRP) has developed a system of monitoring based on 25 easily-identified species representative of different feeding types and a predictive stream model based on chironimid larvae. If a concentrated effort were based on ecological relationships, a simple early-warning system using a few species could protect living resources.

This approach should be tiered to maximize information, minimize collection, and analyze costs. If changes are seen relative to reference stations, then more comprehensive work, for example, GC/MS, is suggested. If there are no changes in the community's natural fluctuation, then more comprehensive analyses are not needed.

User--
EPA would use it as an enforcement tool; NOAA for ecosystem research alert; industry for identification of research and treatment needs.

Time--
This program would take two years to implement.

Sediment Kinetics of Pollutant Transport

Two fractions of solids input require concentrated research because in many cases they have a dominant impact on living resources:

- Flocculant organic materials (floc) transported across the continental shelf
- Fines fraction of marine sediments

Floc settles in the swales and is eaten by sand dollars, polychaete worms, foraminifera, amphipods, isopods, and a host of organisms at the bottom of the food chain. This material is highly organic and has a gelatinous structure with many charged active sites. This property enables the material to be an active scavenger for heavy metals (in most of their forms), slightly soluble organics (for example, carcinogenic polynuclear aromatics), and bacterial and viral particles. Disease, toxicants, or bioaccumulative materials may enter the marine ecosystem through this material.

Fines are highly charged silt and clay particles that are ideal substrates for bacteria. Like floc, they attract charged ions. Bacterial slime (the gelatinous matrix surrounding many bacterial cells) scavenges for organics and metals as the particles move through the water column.

Benthic organisms eat these particles and are eaten, in turn, by other living things. The movement of pollutants is basically that of sediment transport.

Information Needs--
The equilibrium, absorptive capacity of the floc and fines must be determined for organometallics, ionic metal species, synthetic organics, etc. In addition, the adsorption, desorption kinetics and bioavailability of these materials to benthic organisms must be determined.

These data will foster an understanding of primary pollutant transfer. They would aid marine pollution specialists in understanding ecosystem dynamics.

Current Collection--
A well-defined, systematic study of these mechanisms is necessary, but none is in progress. The study should not be conducted in isolated segments.

Examples studies should be noted:

Galloway, J.N. 1972 "Man's Alteration of the Natural Geochemical Cycle of Selected Trace Metals," University of California, San Diego, 143 pp.

Peterson, L.L. 1974 "The Propagation of Sunlight and the Size Distribution of Suspended Particles in a Municipally Polluted Ocean Water," PhD Dissertation, California Institute of Technology, Pasadena, 174 pp.

Standardization of Marine Pollution Analysis Methodologies

There are no preferred methods for marine pollution monitoring--the marine equivalent of Standard Methods for the Examination of Water and Wastewater. If many laboratories are performing the same analyses, then the data generated must be equivalent. Therefore, methods with known precision, accuracy, and interlaboratory calibration are essential.

User--
All laboratories performing marine pollution monitoring would require this assurance.

Time--
This can be accomplished within two years.

Inadequate Bioassay Methodology

Acute and chronic testing of pollutants is generally conducted on the individual organism, in a manner which is irrelevant to environmental exposure, and in artificial conditions. These data are almost irrelevant to the real world!

A community bioassay approach conducted under realistic exposures (e.g., decay of concentration with time) are sorely needed. Refinement of such studies as larval recruitment, succession, and benthic communities would yield more valuable information than the standard EC_{50} or LC_{50}.

Users--
Marine pollution specialists wishing to predict the real inpact of pollution on living resource communities would have a need for community bioassays.

Time--
The program would take three years to implement.

Reference Compounds

In order to calibrate analytical techniques, standard reference materials are needed. The National Bureau of Standards should be funded to provide standard reference materials for marine nutrients, organometallics, polynuclear aromatics and other important pollutants.

Users--
All researchers in marine pollution would need to calibrate analytical methodology.

Time--
Ongoing as new needs are discovered.

Fisheries Resource Management

Overfishing of many organisms is a serious problem. We must seek optimum ways to control overfishing in order to preserve an adequate stock of marine resources. Therefore, we must continue to develop international relations, positions, and economic incentives so that other governments will develop prudent harvesting policies.

Users--
Negotiating teams.

Benefits--
All users of marine resources, including state, local and regional fishery councils.

Damages Created by Resource Harvesting

The harvesting of living resources disrupt local ecology. For example, scalloping turns over the continental shelf at least once every five years. We should determine the impact of these operations on the marine ecosystem, especially when we try to segregate the effects of pollution from resource harvesting.

Users--
All pollution monitors.

RANKING OF PRIORITIES FOR RESEARCH, DEVELOPMENT AND MONITORING

The Living Resources Panel concluded its discussions with a Priority Ranking System in which a numerical factor of 7 was the most important and 1 the least important. The projects and their averaged rank follow:

Priority	Point Rank 1 - 7	
1	6.3	Standardization of marine pollutant analysis methodologies
1	6.3	Source control of hazardous materials before release
2	6.0	Need for information on distribution, nature, and impact of certain pollutants
3	5.5	Screening/Monitoring marine ecosystems for unknown effects
4	5.3	Fisheries waste processing - low-cost treatments needed
4	5.3	Sediment kinetics of pollutant transfer
5	5.2	By-Product development of useful substances from wastes
6	5.1	Effect of synergistic inputs to a marine system
7	5.0	Longevity of chemical residues in the marine environment
8	4.8	Fisheries resource management
9	4.7	Disease transmission--viral, parasitic, etc.
10	4.5	Recycling of sludge wastes
10	4.5	Inadequate bioassay methodology
11	4.3	Effect of losses of quality and productivity of land resources
12	4.0	Need for analytical reference compounds
13	3.8	Minimization of any damage caused by resource harvesting

SECTION 6

MARINE TRANSPORTATION

PANEL REPORT

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INTRODUCTION

The Transportation Panel was charged with producing a list of information needed to regulate ocean uses and to prevent or minimize pollution, including a description of who needs the information, why it is needed, in what time frame, whether it is being adequately compiled now, and any serious problems anticipated in obtaining it.

DESCRIPTION OF MARINE TRANSPORTATION

Hazardous Substances Spills from Marine Transportation

Level and Location of Activity--

The problem of hazardous spills resulting from marine transport is worldwide, but no good data are available on the kind, quantity, or location of spills. The bulk shipment of chemicals is an extensive operation, warranting careful research and monitoring.

Value and Importance of Activity--

Bulk shipment of chemicals is economically necessary, and hazardous substances cargoes (shipped via tank vessels and barges) are essential to commerce and industry. There is a need to examine whether it would be worthwhile to transport certain hazardous substances which are extremely damaging to the marine environment and the population on land using rail, highways or pipeline, rather than on water.

Environmental Quality Concerns--

Chemical properties and environmental factors affect the nature of spill damage. When chemicals are examined, their toxicity to marine biota, their solubility, biodegradation potential, vapor pressure, density and other basic properties should be understood. Environmental factors to be considered include wind, temperature, water depth, location and biological populations at risk.

Damage from spills can have short- or long-term effects. Short-term effects may be that a chemical exerts acute, toxic action, after which it disperses or degrades, as is the case with formaldehyde or sulfuric acid. Long-term effects may be seen when a material resides in environmental "reservoirs," and exerts a chronic, toxic effect, as is the case with DDT, Kepone, PCBs or Mercury.

National Decision Processes Related to Activity--

The relationships and responsibilities of government agencies such as the Environmental Protection Agency, Department of Transportation, and Council on Environmental Quality need to be developed. Consideration should also be given to the Intergovernmental Maritime Consultative Organization's (IMCO) standards for hazardous cargo shipment and the Federal Water Pollution Control Act, PL 92-500, Section 311, as amended.

Limiting Factors--

Limiting factors can be separated into the scientific, technological and legal categories. Scientific limitations include the lack of knowledge about ecosystem behavior and the effects of most chemicals transported. The methodology for monitoring and detecting hazards for most chemicals transported is inadequate.

The basic technological limitation is the lack of developed new technologies and logistics for spill cleanup of hundreds, possibly thousands, of compounds with a wide spectrum of physical and chemical properties. The possibility and effects of treating certain chemical spills with other chemicals, i.e., using a base to treat an acid spill, should be investigated.

Legal limitations were imposed while the hazardous substances program was blocked by Federal court decision, but these were lifted as of October 15, 1978.

Information Needs--

Information needs include a requirement that spill information be reported to the National Response Center. A trend analysis of spill data is needed.

<u>Oil Pollution Resulting from Marine Transportation</u>

Level and Location of Activity--

The frequency of spills is fairly consistent from year to year and can be analyzed by classical statistical methods. The total number of spills from all sources is approximately 10,000 per year. In 1977, the regional distribution of spills by percentage was as follows:

Atlantic Coast	21.6%
Pacific Coast	16.3%
Gulf Coast	29.2%
Great Lakes	4.7%
Inland	28.2%

The volume of oil spilled, however, varies from year to year, and a few large spills account for the major portion. Spills of over 100,000 gallons make up less than one percent of the total number, but 70% of the volume. Although small volume spills can be treated by classical statistical methods, the few large spills cannot. Bayesian statistical methods have been suggested for analyzing large spills. The range in volume of spills from 1973 to 1977 was 15 to 23 million gallons. The range by region for 1973 to 1977 is as follows:

Atlantic Coast	1.6 - 8.8 million gallons
Pacific Coast	0.5 - 1.6 million gallons
Gulf Coast	2.5 - 7.0 million gallons
Great Lakes	0.3 - 0.7 million gallons
Inland	3.1 - 8.3 million gallons

Oil accounts for roughly 80% of reported spills, both in frequency and volume.

In the 1973 to 1977 period, spills were more frequent in May, July and August, but spills of large volumes occurred in January, October and December. Vessels (1977 figures) were responsible for 33.1% of all spills and 66.1% of the total volume spilled. Causes of vessel spills are:

- Grounding and strandings in 67% of all cases
- Collisions in 19%
- Structural or mechanical failure in 14%

One must also consider port calls, traffic density, vessel type and specific port in order to examine the total activity properly.

Value and Importance of Activity--

Tankers are the only means of moving foreign oil to the United States. This imported oil constitutes greater than 50% of the U.S. supply annually. Barges provide economical bulk transport of refined products.

Environmental Quality Concerns--

Various conditions affect oil spill impact; these include:

- Volume spilled
- Type of oil (refined, crude, etc.)
- Location of spill (the importance to man's welfare and the biological populations at risk)
- Environmental conditions at the time, such as wind, temperatures, water depth, currents, turbidity, etc.

Spills may damage fish and wildlife, wetlands and nursery areas, beaches, commercial and recreational fishing, tourism, human health (through consumption of contaminated seafood) and public or private property.

National Decision Processes Related to Activity--

Decision-making processes related to marine transport take the form of international legislation and agreements, and United States legislation. A number of international conventions have focused on this activity; they include:

- Prevention of Pollution of the Sea by Oil (1954)
- Safety of Life at Sea (1960 + 1974)
- Amendments to Oil Pollution Convention (1962)
- Load Line Convention (1966)
- Amendments to Oil Pollution Convention (1969) - limits operational discharges to 15 ppm within 50 miles of land
- Intervention Convention (1969) - invoked in Argo Merchant disaster
- Compensation Fund Convention (U.S. has not ratified)
- 1973 Marine Pollution Conference - action pending
- International Conference on Tanker Safety and Pollution Prevention (TSPP,

February 1978)
  - improvements inspection and certification
  - improvements vessel construction and equipment
- International Convention on Standards of Training, Watch Keeping, and Certification of Seafarers (June 1978)

United States legislation dealing with marine transportation includes:

- Oil Pollution Control Act of 1961 (PL 89-167)
- Oil Pollution Act Amendments of 1966 (PL 89-551)
- Intervention on High Seas Act (PL 93-248)
- FWPCA of 1972 (PL 92-500) - §311
- Clean Water Act 1977 Amendments to §311
- Marine Protection Research and Sanctuaries Act (PL 920-532, amended by PL 93-254)
- Ports and Waterways Safety Act of 1972
- Ports and Tanker Safety Act of 1978 (PL 95-474)

Limiting Factors--

Limiting factors are of a scientific, technological, economical and political nature. Scientific constraints include the lack of information on the long-term ecological impact of spill events in differing geoclimatological zones. Another limitation is imposed by the inadequacy of present biological cleanup agents (packaged bacteria, fungi, etc.).

Technological constraints are apparent in the following areas: structural and mechanical failure, governed by economics as well as technology; collision avoidance systems which are not accepted worldwide; spill cleanup systems which are inoperable beyond very modest sea-state; burning techniques which require further development; and the need to reexamine the use of dispersants for offshore oil spills when standard cleanup systems are inoperable.

Economic constraints and uncertainty of effectiveness impact the rate of acceptance of alternative features. Such constraints affect use of double bottoms, segregated ballast tanks and other design features as well as advanced navigational and communication systems, back-up propulsion and steering systems. Economics also places limits on vessel size, type, use of specific ports, and crew training.

Political limitations center around the view that oil is an instrument of national policy and security.

CONCLUSIONS AND RECOMMENDATIONS FOR RESEARCH AND MONITORING NEEDS

Although much information is obviously needed on fate and effects of oil and hazardous substances that enter the marine environment, the Panel did not formulate a list of national needs with regard to those factors. Rather, the discussion was restricted to the transportation of hazardous substances by water, broadly defined to include every state of handling in connection with such transportation (terminals, cargoes, vessels, personnel, communication/navigation, environmental operating conditions, accident response, contingency planning and cleanup, and the institutional/legal framework). It was noted that marine transportation includes 60,000 ocean-going vessels worldwide, a minority of which (10%) carry oil and hazardous substances. All vessels should be viewed as possible polluting sources, or as capable of contributing to the accidental release of oil or hazardous substances from those carriers. There are also a substantial number of inland vessels to be considered.

In general, the panel expressed greater concern about chemicals than about oil and noted that no legislation at the Federal level presently requires that spills of all hazardous substances be reported. Obviously, products that are moved, the method used to move them, the risks associated with transportation of those materials, and details of all spills need to be known. Disclosures should be required of owners of materials to governments and to transporters, even if arguably proprietary. Similarly, notification requirements for vessels in danger, including information on their cargoes, need to be instituted so that adequate responses can be made quickly. There was complete consensus that the prevailing rules and practices regarding salvage are inappropriate for modern conditions, and that a high priority should be placed on developing new international salvage rules.

A complete list of potentially dangerous hazardous substances should include such items as spent nuclear fuel rods, fertilizers, certain ores, and many other commodities and chemicals. Research on the danger of such spills to humans and to the marine environment should be linked to information about the authority, if any, which is regulating the pertinent activities, the degree of regulation, etc. Only after such analyses will it be possible to determine rational strategies for new transportation requirements.

Any complete regulatory framework must include rules and enforcement capability regarding operational handling and discharges, prevention and mitigation of accidents (including vessel design, technological features and personnel training), cleanup and liability/compensation regimes to cover accidents.

A general risk analysis of the various available transportation alternatives is necessary to an evaluation of value and importance of an activity.

There are instances in which uncoordinated efforts and indecision within federal, state, and local governments inhibit progress.

The attached preliminary list of needs is subdivided into eight major categories. The Panel also identified areas of need within each category, and assigned preliminary priorities to each area. Due to the haste with which the work was accomplished, the Panel is concerned that it may have missed some very important needs.

The Panel quickly concluded that it had little or no expertise in the fate and effects of pollutants. Accordingly, it felt that its greatest contribution would be in addressing how pollution incidents can be prevented or mitigated within the marine transportation mode. All this notwithstanding, the Panel stated that the performance of needed research on the fate and effects of hazardous pollutants cannot be overemphasized and is of the highest priority.

While the list of needs includes a number of high priority projects, the Panel felt that the most important areas in marine transportation are:

a. Personnel, and
b. Institutional and legal ramifications.

Time restraints also prohibited the panel from fully discussing the needs in terms of user of research, purpose, time-frame, adequacy of present information and data acquisition. In closing, the Panel expressed the desire that future marine transportation panels include someone with expertise in chemical carriers.

NEEDS AND PRIORITIES FOR RESEARCH AND DEVELOPMENT AND MONITORING

Need	Priority
CARGO	
• Profile Projection of Marine Transport	High
Identify for All Cargoes: - Volumes - Location (Routes, Ports) - Type Vessel(s) Used Size, etc. Purpose: Trend analysis for identifying future problems Data Acquisition: Government, Industry - Much raw data available - Little digested analysis - Com./DOT/DOE et al, DOD/Treas. - Associations/COS	
• Impact	High
Identify for All Cargoes: - Hazard(s) to Personnel - Hazard(s) to Marine Environ - Possible Traffic Impact - Air Quality - Other Industries Purpose: Fundamental data needed to assess risks associated with transportation of each substance Data Acquisition: Oil - Much data on short-term effects - Less data on latent effects Hazardous Polluting Substances - Some data on short-term effects - NIL data on latent effects - Significant short-term data gaps - Very dynamic situation and high growth rate of new substances - Little knowledge of interactive effects Sources - Scientific community in Govt/Industry/ Academia Gesamp/Inter	
VESSELS/EQUIPMENT	
• Oil in Water Monitor	High
• Profile Projection of Vessels	High
- Nos., Sizes, Types, Flag - Ocean/Inland - Applicability of TSPP Reqts.	
• Emergency Cargo Transfer Capability	Medium
• Redundant Equipment	Medium
- Nav./Commun. - Propulsion - Steering	
• Vessel Design	Medium
• Nuclear Propulsion	Medium
- Hazard to Environment	
PERSONNEL	
• Profile of Various STD/Requirements	High
- Education - Training - Experience - Manning - Certification	

Need	Priority
• Degree of Implementation/ Enforcement	High
• Owner/Crew Relationship	High
- Familiarity - Continuity - Motivation	
• Reasons for Failures	High
- Human Error - System Error	
• Procedural	High
- Normal Operations - Emergencies	
• Pilots	High
- Training - Regulation	
TERMINALS	
• Site Selection for Certain Cargoes	High
• Reception Facilities	High
• Onshore vs. Offshore Terminals	High
• Litering	Medium
• Air Emissions	Medium
• Port/Channel/Bridge Configuration and Location/River Dikes	Medium
ENVIRONMENTAL OPERATING CONDITIONS	
• Current Predictions	Medium
- Accuracy/Availability	
• Weather Data	Medium
- Arctic - Other areas	
COMMUNICATIONS/NAVIGATION	
• Vessel Traffic Service	High
- Evaluation - Future Needs - Various Levels	
• Language	High
• Electronic Navaids	High
- Satnav - Loran/Decca - Omega - Collision Avoidance Aids	

Need	Priority
• Charts	High
• Traffic Separation	Medium
• Rules of the Road	Medium
- Evaluate Colreg '72	
• Short-Range Navaids	Medium
INSTITUTIONAL/LEGAL	
• Salvage/Law Compensation	High
• Better Monitoring Capability for Operational Discharges	High
- Type Pollutant - Flag - Area	
• Substandard Ship Identification	High
- Owner - Age - Flag	
• International Enforcement Capability	High
- Resources - Experience	
• Pilotage	High
• Liability/Compensation	High
- Oil - HPS	
• Flags of Convenience	High
ACCIDENT RESPONSE	
• Better Salvage Arrangements	High
- Legal - Operational/Technical	
• Adequacy of Salvage Equipment	High
- Tugs - Lighters - People	
• Spill Response Capability	High
- Cleanup - Containment - Dispersal - Mitigation for HPS	

SECTION 7

MARINE WASTE DISPOSAL

PANEL REPORT

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INTRODUCTION

The materials of concern with regard to marine waste disposal fall into the categories of sewage sludge, industrial waste, dredged material, radioactive waste, municipal waste, pollution from non-point sources, and atmospheric input. The disposal processes by which these materials enter the marine environment are ocean dumping, ocean incineration, deep ocean waste emplacement, ocean outfalls, and riverine inputs.

DESCRIPTION OF NEEDS

Level and Location of Disposal Activities

In 1977, sewage sludge accounted for 5,134,000 tons of ocean-dumped materials. Sewage sludge dumping was confined entirely to the New York and Mid-Atlantic Bights. By comparison, 1,783,600 tons of industrial waste were ocean dumped, again mostly in the Mid-Atlantic Bight. While 60,200 tons of industrial waste entered the Gulf of Mexico or the Pacific Ocean in 1978.

By far, dredged material accounts for the greatest amount of ocean-dumped waste. If a conversion factor of 1.43 tons per cubic yard is applied, a total of 59 million tons of dredged matrial was marine-disposed in 1977. Dredged material disposal was distributed as follows:

20.7 million tons - Atlantic Ocean
18.0 million tons - Gulf of Mexico
20.3 million tons - Pacific Ocean

There has been no United States sea disposal of low-level radioactive wastes since 1970. However, four sites of previous low-level radioactive waste disposal exist. Two of these are in the Pacific, 40 and 50 miles off the coast of San Francisco, and two are in the Atlantic, 120 and 200 miles off the coast of Maryland and Delaware. Some European countries continue to ocean dump radioactive waste, and Japan plans to utilize sea disposal in the future.

Ocean incineration is a disposal process of somewhat less concern than dumping. The Panel had insufficient information to fully analyze the significance of incineration. So far, ocean incineration has been used primarily to dispose of industrial waste. Since 1974, 34,443 metric tons of organochloride wastes and 12,112 wet tons of herbicide orange have been incinerated.

Deep ocean waste emplacement has been considered primarily as a disposal option for high-level radioactive waste, but this activity is prohibited by the Ocean Dumping Act.

Ocean outfalls comprise a large and diverse category of disposal processes. Uncertainties in the inventory of outfalls arise from the lack of information on location of outfalls and inadequate computer files. Approximately two billion gallons per day are discharged into the territorial sea and the contiguous zone, and some 170 municipal and 80 industrial dischargers are contributors. Half of the total is contributed by four outfalls in California alone. In addition to these, a far greater but less well defined number of outfalls dispose a somewhat smaller volume into the bays and saline estuaries of the U.S. The total estimated flow is 3,500 MGD.

According to a recent EPA survey, "Economic Impact Analysis of Ocean Discharge Regulations," the location and total MGD of ocean outfalls are given by EPA region in the following list:

Region IX	(California, Hawaii)	- 1455 MGD
Region II	(New York, New Jersey Puerto Rico)	- 225 MGD
Region IV	(Florida)	- 206 MGD
Region X	(Pacific Northwest)	- 24 MGD
Region III	(Mid-Atlantic)	- 5 MGD
Region I	(New England)	- 2 MGD

These figures do not take into account outfalls discharging into bays and estuaries. (Power plants are not included in the industrial category, since most discharge into bays and estuaries.) Section 301(h) of the Federal Water Pollution Control Act may include dischargers in Alaska, Washington, Delaware, Virginia, Massachusetts and Connecticut, which are not included in the figures above. Some 133 municipal dischargers produce total effluent of approximately 1,600 MGD, and industrial and other dischargers produce effluent in excess of 400 MGD. The level of treatment is not differentiated in these data.

Among sources of riverine pollutants are areawide runoff, salt brines from oil wells and natural seeps, pollutants in industrial and municipal wastewater, irrigation return flows, stormwater overflows, and oil and hazardous material spills. The Waste Disposal Panel was concerned with riverine pollutants only to the extent that they contribute to ocean pollution and recognized some overlap with the Coastal Development and Recreation Panel activities.

Value and Importance of Marine Waste Disposal Features

Several physical, chemical and biological features make the ocean a unique and valuable resource for waste disposal. The surface area of 361 million square kilometers and volume of 1370 million cubic kilometers offers space in which to dispose of wastes without direct interference with other human activities. Because water is kept in motion by the forces of the earth's rotation and by wind and tidal forces, waste entering oceans and nearshore waters is transported away from the area, dispersed and diffused. A large portion of the ocean floor is at depths exceeding 10,000 feet. Near-freezing temperature, immense pressure, stability, and isolation may be valuable features for the disposal of some forms of waste, but unsuitable for others.

The chemical composition of seawater, a 3% solution of mineral salts, is significant to waste disposal, because it augments the transformation of many types of materials of natural or synthetic origin into other forms available for recycling through food and technological use chains. The buffering capacity of seawater allows strong acids and alkali to be assimilated with only localized impacts on pH. Biological characteristics favoring utilization of oceans for disposal include the food value of certain wastes for marine biota and capacity for biological degradation as a means of waste treatment. The oceans' assimilative capacity is large but not infinite. Limitations on assimilative capacity are dependent upon type of pollutants, time, and other factors.

Environmental Quality Concerns

There are many concerns for environmental quality involving marine disposal. The smothering of bottom communities by large quantities of solid, especially dredged material, is an obvious concern. Pathogenic organisms can also be introduced into the ocean. Changes in concentrations and speciation of toxic materials--including carcinogens, mutagens, and teratogens in sediments--can give rise to subsequent contamination of marine food chains, including seafood for human consumption.

Long-range impacts of dumping synthetic toxic materials require special consideration. Ocean dumping may be only one of many sources. Accumulation of toxic substances over long periods of time may ultimately degrade large parts of the ocean despite its vastness. Potentially, after perhaps hundreds of years, toxic materials deposited in the deep ocean under a "cold storage" regime can be mobilized and can return to the biosphere via currents moving toward the surface or via benthic organisms. As in all environmental systems, there may be effects on particularly sensitive biological communities, such as coral. Radioactive waste must be considered in many of the same ways as toxic materials. There are possible health effects if large volumes of nuclear waste result in radionuclide transmittal through the food chain to man. Sediment resuspension from offshore disposal sites is also possible.

Ocean outfalls present problems. They are stationary and discharge into nearshore waters where biological activity is high and where their effects are most likely to compound those of other human activities. Because they discharge into nearshore waters, ocean outfalls also have a more immediate effect on human activities such as fishing or water contact sports. A significant potential for environmental damage exists from both short- and long-term effects. Chemical properties of the receiving waters can be altered and biological communities seriously endangered. The effects can result either from an influx of conventional pollutants at a more rapid rate than can be assimilated by the ocean, or by long-tern accumulation of pollutants. The fact that effects of discharge are poorly understood is exemplified by the controversy regarding the relative sensitivity of estuaries as opposed to the open ocean.

National Decision Processes Related to Marine Waste Disposal

A considerable body of Federal laws and regulations, as well as state laws, are concerned with marine waste disposal directly or indirectly. The Panel did not make an exhaustive study of these laws, but in its discussions attempted to highlight some examples of legal constraints on the decision-making process.

The permit program for ocean dumping is mandated by the Marine Protection, Research and Sanctuaries Act of 1972, as amended. This domestic legislation implements the international Ocean Dumping Convention. It regulates ocean dumping, including incineration at sea and deep sea emplacement of waste. Responsibility for administration is shared by EPA and the Army Corps of Engineers (COE). COE is responsible for issuing permits for ocean disposal of dredged materials, while EPA is responsible for issuing permits for other than dredged materials, for establishing criteria for ocean disposal, and for designating disposal sites for all materials.

Several aspects of the National Pollutant Discharge Elimination System (NPDES), mandated by the Federal Water Pollution Control Act (FWPCA), relate to marine pollution. Section 402 requires point source dischargers of pollutants to obtain permits to discharge. These may be issued and administered by the state into whose waters the pollutants are to be discharged, if that state has been given authority by the EPA Administrator. The majority of states have been delegated this authority. EPA review rights may not be waived if the discharge is to marine waters, and under 309 of FWPCA, EPA retains the right to enforce the permit either civilly or criminally. Permits almost universally require permittees to sample discharges and report pollutant levels; they also require that the permittee report compliance with schedules for attainment of required effluent goals. Permits to municipalities require that the municipality control industrial discharges to their systems. Permits may also be written for aquaculture projects and sewage sludge disposal.

Ocean outfalls are addressed in the FWPCA. Section 301(h) requires publicly-owned treatment works to conduct marine monitoring programs. They must also satisfy a number of other requirements as a condition for temporary exemption from the mandatory secondary-treatment requirement, with exemptions to extend no longer than 1983. The monitoring programs provide continuing documentation that the permit modification is not causing adverse environmental impacts in each specific case. Furthermore, it will provide EPA with environmental observations which, when assembled and evaluated, will aid in decisions about whether the law should be changed or the exemption extended. Under Section 403(c), EPA will propose more stringent requirements for writing permits for ocean discharges into territorial seas and beyond. Regulations under Section 403(c) have not yet been promulgated. One possible regulatory approach will require monitoring similar to that done for ocean outfalls. It would be conducted so that waivers could be received under Section 301(h) and so that damage to the marine environment could be identified by such monitoring and additional treatment prescribed.

With respect to regulation of dredged and fill activities, permits are required under Section 404 of the FWPCA and by the Rivers and Harbors Act. In traditional navigable waters, the COE has responsibilities for dredge and fill programs, while in other U.S. waters, the states may be delegated the responsibility for the deposition of dredged and fill material. The role of EPA has been to provide an overview of all permitting and to authorize states to establish programs for traditional non-navigable waters.

Other statutory authority relating to marine waste disposal includes:

- Federal Water Pollution Control Act
  - --Sewage Treatment Construction Grants Program
  - --Section 311
  - --Section 208 Planning
- Sea Grant Program
- International Treaties
- Coastal Zone Management Act, Management Plans
- Deep Water Ports Act
- OCS Lands Act
- National Environmental Policy Act

Regulation of radioactive waste disposal to oceans is primarily an EPA function. Regarding low-level waste, EPA is required to establish interim regulations by 1980 under the Marine Protection, Research and Sanctuaries Act (MPRSA), as amended. These regulations are to include acceptable criteria for site selection, site designations themselves, packaging criteria, a listing of potential classes of acceptable waste, and an acceptable monitoring program. Final criteria are due in 1983-85, depending upon resources and manpower. In fulfilling its responsibility, EPA must take note of the Ocean Dumping Treaty to which the United States is a signatory. Specific regulations for sea disposal of radioactive wastes have been promulgated by the International Atomic Energy

Agency. That Agency has been designated the competent international body in this field pursuant to Annex I of the Treaty. The Ocean Dumping Treaty requires a minimum disposal depth of 4000 meters (recently changed from 2000 meters); no dumping north of 50 degrees of N latitude or south of 50 degrees S latitude; that all inland seas, areas of trans-oceanic cables, known energy and mineral exploration areas and commercial fishery areas are excluded. Release rate limits and containment recommendations are included in the treaty; predumping notification and consultation procedures are also designated. EPA is also the lead agency for a NEPA-required statement on radioactive waste disposal. Ocean dumping of high-level radioactive waste, including sea bed emplacement, is prohibited under MPRSA. The ocean dumping of high-level radioactive wastes is similarly prohibited under the Ocean Dumping Treaty.

Limiting Factors to Making Decisions Regarding Marine Waste Disposal

As in other areas of environmental activity, the decision-making process is impaired by factors relating to scientific and technical understanding, and to economic and policy issues. First of all, scientific knowledge is lacking about actual effects of marine waste disposal; the impacts of certain wastes need to be defined and reversibility determined. The assimilative capacity of the marine environment is poorly understood, and comparative scientific data is lacking about the relative impacts of alternative methods and locations of waste disposal and recycling. Most research focuses on understanding fundamental processes and minimal efforts have been undertaken for study on continental shelf areas where nearly all pollution problems exist. Criteria for regulating disposal of wastes in the ocean were originally set on a "best guess" basis because of this lack of knowledge. The regulatory approach is still based largely on extrapolations from laboratory test procedures to actual impacts on the marine environment. Therefore, criteria used to phase out dumping may actually be more stringent than needed to protect the environment. The data base necessary to analyze effects and fates of riverine discharges is also inadequate.

The research has also been limited and inadequate on such topics as the fate, behavior, and effects of radioactive waste which has been dumped. Pathways to man, deep sea current measurements, sediment resuspension, core sediment sampling, multiple-barrier approaches to containment, and bioassay techniques for radionuclides and toxic waste need further investigation.

The data base for evaluating and predicting effects of ocean discharges is meager. Special emphasis should be placed on baseline studies of biological communities, effects of exposure to pollutants on individual species, and physical aspects of ocean discharges. Such studies should account for regional variations resulting, on the one hand, from current, temperature, topography and species type, and on the other, the effects of particular pollutants discharged in a given area.

Assessment of ocean dumping impacts is especially compromised by a lack of scientific knowledge, which is at a more elementary level for dredged material than for any other currently ocean-dumped waste. The gaps in knowledge regarding ocean dumping are more scientific than technological, whereas technological limitations are greater with respect to better land-based disposal. There are limitations on coastal and inland engineering technology and management controls required to minimize sediment movement into navigation channels. Progress in this area would reduce the need for dredging and subsequent ocean disposal of dredged material, as well as limit non-point source discharges into rivers.

Economic factors influence decision-making. Alternative methods of disposal are almost always more expensive than ocean disposal, and in some cases, prohibitively so. Frequently, land-based methods have environmental effects which can be as deleterious as those of ocean-based methods. The environmental and economic costs of land-based and ocean disposal vary according to the location. A mechanism for considering various alternative means of disposal already exists in some cases (e.g., 201 facilities planning process for ocean outfalls). Lack of adequate data about environmental effects of a method or location of disposal can, however, reduce the validity of economic choices. In addition, current policy regarding construction grants for publicly-owned treatment works biases a choice of alternatives toward relatively capital-intensive solutions. The potential hazards in the disposal of radioactive waste dictate that economic considerations might--or should--not be the primary determinant.

Several sociological factors impinge on the decision-making process. No one owns the oceans; therefore, marketplace realities do not apply. There is considerable public skepticism regarding reuse of sludge and wastewater.

Public perceptions of ocean disposal, however, are such that the ocean dumping alternative may not receive full consideration. Dischargers do not necessarily bear the consequences of the impacts of ocean disposal; although they reap the benefits, impacts are borne elsewhere. Government jurisdiction over the oceans is widely accepted.

The public perception of radioactive waste disposal is such that it is necessarily treated differently from other wastes.

Scientific constraints to be considered are insufficient knowledge of marine ecological systems and insufficient information about relative environmental costs of ocean and land-based disposal methods. Differences among regions compound the problem. As a consequence, environmental waste disposal decisions tend to be influenced by whose "ox is being gored."

The policy, institutional, and legal ramifications are complex. Currently, land-based alternatives are emphasized. Construction grants policy presently favors a selection of capital-intensive waste treatment alternatives. Policy decisions should be made with a degree of conservatism proportionate to the degree of risk involved or the availability of information about the consequences of the decisions. The less information available or the greater the potential risk, the more conservative should be the chosen alternative. State and local laws may limit alternatives for waste disposal. For example, states currently prohibit nuclear waste disposal within their borders, and state water quality and land-use regulations limit alternatives.

Several aspects of monitoring must be considered in the decision-making process. There is a need for a consistent national methodology for all studies. Standardized techniques for monitoring the marine environment and ecosystems are needed so that relative effects in polluted and nonpolluted areas can be determined. Good science, defensible in court, and requirements for chain of custody are legal aspects of the monitoring problem. Continuous monitoring using sealed recorders for parameters such as dissolved oxygen, pH, conductivity and temperature is necessary. Calibration is a problem for such systems. There is a need for better analytical techniques. Though standards exist for trace metals and petroleum hydrocarbons, laboratories should, nevertheless, intercalibrate; and care should be taken to prevent overlap and duplication in the development of analytical techniques. ASTM should be of service in this area. Guidelines and standards for monitoring should be developed. Monitoring should be carried out by an organization other than the discharger, but funding should be by the discharger--proportionate to volume or effects of waste discharge.

RECOMMENDATIONS

To develop a rational program for ocean pollution research, development, and monitoring relative to marine waste disposal, one must:

1. Quantify regionally, and preferably synoptically, the sources and rates of addition of significant pollutants and other materials which reach the marine environment as a result of human activity.
2. Evaluate the effects of the quantified materials on marine resources and uses thereof. Included here is the evaluation of the fates of the materials.
3. For materials which have greatest actual or potential impact on uses of marine resources, establish the quantities which will interfere with those uses, both spatially and temporally. In other words, establish the marine environment's "assimilative" capacities for those materials for beneficial uses.
4. Develop the institutional framework required to allocate assimilative capacities among the various users of the marine environment. Take into account the scientific, political, social, economic, technological, environmental, institutional, policy, and legal factors which are to be balanced during the allocation process.
5. Contribute, through Federal programs, to the public appreciation of the relative value and importance to society of marine waste disposal activities and their alternatives.

The research and development and monitoring needs, prioritized for the four major sources of marine pollution, are summarized below. Some members of the Panel felt that determination of persistence and bioavailability and development of improved chronic toxicity and bioaccumulation tests were high priority needs for all categories; thus, they chose to emphasize the health implications.

NEEDS AND PRIORITIES FOR RESEARCH AND DEVELOPMENT AND MONITORING

Priority: High	Priority: Medium	Priority: Low	Need
R OD OF RI			Evaluation of potential health effects of persistent pollutants and nuclear waste; evaluation of ocean pathways to man.
OD OF R RI			Evaluation of the distribution and persistence of pathogens and toxics pathways back to man (carcinogens, mutagens, teratogens).
OD OF R RI			Development of analytical quality control methods for use on a routine basis and standardization of monitoring techniques.
	OD (High for some substances; Low, for others) OF R		Determination of persistence and bioavailability of synthetic materials in the marine environment, including specific analyses of trophic level transfers (food chain, etc.).
R OF		OD	Development of improved methods of continuous long-term biological monitoring.

Priority High	Priority Medium	Priority Low	Need
R OF	OD		Combined laboratory and field bioassay studies to relate present bioassay techniques to field impacts.
R	OD OF		Development of improved chronic toxicity and bioaccumulation test procedures for use in monitoring on a routine basis.
R	RI	OD OF	Physical dispersion characteristics, i.e., areas of upwelling, currents, sediment resuspension, velocity; longer term cycling of radioactive material and other persistent pollutants.
		OD	Improvement of technology for incineration at sea.
	RI OF	OD	Evaluation of limiting nutrient species in particular coastal areas.
R			Development of isolating media (impermeable to high pressures, chemical dissolution).
OD			Development of criteria for assessing sediment quality for routine use to determine suitability of methods of disposal.

Priority High	Priority Medium	Priority Low	Need
R		OD	Development of acceptable methods for seabed emplacement of hazardous materials.
OD R RI	OF		Development of public awareness programs.
OD OF R RI			Development of feasible methods for altering the volume and kinds of materials reaching the ocean.
OD OF R RI			Monitoring of existing ocean disposal sites according to requirements of the EPA ocean dumping and site selection criteria (40 CFR, Sections 227 and 228).
OD		OF	Evaluation of recovery rates of impact areas.

KEY:
- OD = Ocean Dumping
- OF = Ocean Outfalls
- R = Radioactive Waste Disposal
- RI = Riverine Pollutants

SECTION 8

MINERAL RESOURCES

PANEL REPORT

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INTRODUCTION

The Mineral Resources Panel adopted a variety of definitions or boundary conditions. In discussing "ocean pollution," it chose to emphasize deleterious anthropogenic activities, rather than strictly adhering to to the definition provided in the law, i.e., "any short-term or long-term change in the marine environment."

Although the Great Lakes were to be included in the Panel's deliberations, this Panel did not survey pollution problems of the lakes in detail. It did indicate, however, that taconite tailings in the Great Lakes may require special research, development and monitoring activities.

The Panel also considered the question of research into geologic hazards. While it is only an indirect cause of ocean pollution, the presence and effect of geological hazards are extremely important in the permitting process governing extraction of mineral resources. Inadequate understanding of geologic hazards may result in the failure of mineral extraction equipment which in turn may cause significant marine pollution.

Finally, the Panel debated the distinction between assessment, survey, mapping, baselines, or benchmarks; and noted that baselines and benchmarks are usually not sufficient to describe or understand the environmental processes in specific geographic areas. Research, as defined in the workshop documents, included surveys, and therefore, an all-inclusive approach seemed warranted. Needs were thus considered in the survey, experimentation and investigation areas.

Three kinds of mineral resources whose extraction may cause ocean pollution were discussed: manganese nodules (ocean mining); oil and gas; and sand, gravel and shells. There are a number of other mineral resources whose extraction may also cause ocean pollution, and these should, therefore, be considered. A list of those minerals might include, but not be limited to:

- Salt, bromine and iodine (obtained through evaporation)
- Gold, tin and diamonds (placer mining)
- Sulphur (Frasch process)
- Aluminum (electrolytic)

- Manganese and sulfides (subsea crustal mining)
- Carbonate sands and phosphates (shelf mining)
- Fresh water (desalination)

One other operation which might be included in the category of mineral resources is the strategic storage of petroleum in salt domes, with its resulting discharge of concentrated brines into the ocean during filling of the storage caverns.

DESCRIPTION OF MARINE MINERAL RESOURCES

Level, Location and Value of Activity

Oil and Gas--

Oil and gas extraction occurs on all shores of the continental United States. At present, more than 3,400 leases, totalling 16 million acres, have been issued. By the end of 1977 there were almost 8,000 operative wells on 2,200 offshore platforms. In addition, more than 100 mobile rigs were operating as far as 150 miles offshore in depths to 2,000 feet. Future sales can be anticipated, since less than 5% of the potentially productive area of the OCS has been leased. The total lease revenue in 1978 was over $1 billion; subsequent royalties will be substantially greater.

Deep Sea Mining--

Manganese nodules and crusts which contain copper, cobalt, nickel and manganese are the focus for this activity. They are found on seabeds throughout the world, in fresh and salt water, primarily in areas beyond national jurisdiction. Commercially exploitable deposits, however will be limited to the eastern equatorial Pacific in the foreseeable future. Although commercial-scale mining is not expected to take place before 1985, estimates of world reserves are on the order of 1,700 billion metric tons. The concentration of metals in some nodules may be several hundred times their concentrations in land-mined ores. Thus, if technological and political barriers can be overcome, deep seabed nodule mining can be an important activity to the United States, both economically and strategically.

Sand and Gravel--

Sand and gravel mining for beach stabilization and construction aggregates occurs in several nearshore areas throughout the country. Most sand and gravel operations are located along the Northeast and California coasts. The volume of material recovered is projected to increase from 44.5 to 82 million tons from 1973 to 1985 and to double again by the year 2000.

ENVIRONMENTAL QUALITY CONCERNS

Potential pollution consequences can readily be seen through an explanation of the technology associated with each mineral extraction process. The technologies and their potential impact are available in a variety of reports dealing with oil and gas or ocean mining.

NATIONAL DECISION PROCESSES RELATING TO MARINE MINERAL RESOURCES

The principal users of research on ocean pollution will be Federal and state agencies. Other users include conservationists and industry.

Department of Interior

USGS - manages oil and gas exploration, development and production activities on the outer continental shelf and provides the Bureau of Land Management and other Federal agencies geological and engineering advice and services in the management and distribution of public lands. It evaluates the probable environmental impacts of exploration, development, and production and prepares for circulation an Environmental Impact Statement (EIS) in accordance with the requirements of National Environmental Policy Act (NEPA). As part of its management function, it also consults with coastal states and coordinates coastal state review of the onshore and nearshore impacts of exploitation of mineral resources. It prepares and distributes summary reports of OCS oil and gas information designed to assist state and local governments in planning for impacts of offshore oil and gas activities.

Bureau of Land Management - prepares a defendable EIS for each proposed OCS lease sale. This EIS forms the basis of the Secretary's decision as to whether a sale should be made final and with what limitations (removal of environmentally sensitive tracts, mitigating stipulations, etc.).

Fish and Wildlife Service - may need research on the impact of OCS activities on the biota, in order to comment on the adequacy of the draft EIS.

Environmental Protection Agency

The EPA issues NPDES discharge permits covering exploration and development activities in the OCS. As part of this procedure, the Agency prepares an Environmental Assessment. Research may also contribute to assessments of the adequacy of the draft EIS and to the preparation of effluent guidelines.

Corps of Engineers

Before issuing a blanket construction permit, the COE must prepare an Environmental Assessment of any major activity. While this assessment will be based largely on the EIS, research in certain areas may be helpful in this process.

National Oceanic and Atmospheric Administration

In addition to commenting on the draft EIS, NOAA is involved in coastal zone management activities, deep seabed mining, environmental and economic studies, and the preparation of position papers relating to the protection of designated marine sanctuaries. Such management activities and subsequent limitations which may be imposed upon industry would benefit greatly from information gathered through improved research, development and monitoring.

National OCS Advisory Board

This Board is composed of appropriate Federal agencies and representatives from the coastal states. Research may satisfy some of the information needs of the affected states. It has been proposed that this Board assume the responsibility for selecting pipeline routes to the shore. Thus, information on the impacts of pipelines on the beaches, estuaries and marshes would be extremely beneficial.

State Agencies

According to 30CFR 250.34, an Environmental Report must be prepared by the lease holder prior to the initiation of either exploratory or development and production activities. This must be approved by affected states.

Leaseholders

In addition to the Federal and state agencies mentioned above, a secondary beneficiary of research will be the oil and gas leaseholders. If adequate research and monitoring information is available to decision makers--

- Delays in the OCS leasing process may be avoided
- Unnecessary lease stipulations and discharge permit limitations can be eliminated
- Environmental Impact Statements (EIS) can be more accurately and efficiently prepared

In addition to the more specific information needs detailed in the following pages, the Panel discussed several issues that, while not direct information needs, were felt to be extremely important and should be considered in the overall planning effort--among them, coordination of Federal marine pollution products and accessibility of data.

A very high priority was placed on the need for studies resulting in predictive models rather than reports of existing conditions. With this in mind, it was noted that perhaps some consideration should be given to undertaking hindcast studies, in much the same manner as weather hindcasting, which has led to improved weather forecasting.

With respect to oil and gas lease areas, some assessments should be made about the importance of requiring biological studies prior to lease sales. The high cost of carrying out such studies before the area has proven to be oil producing should also be considered. Additionally, attempts should be made to coordinate leasing schedules with research timetables.

CONCLUSIONS AND RECOMMENDATIONS

The Panel identified and assigned priorities to a list of specific information needs for OCS oil and gas activities and deep seabed mining. Although some needs for sand and gravel mining, desalination and salt dome extraction were identified, the Panel felt it did not have sufficient representation from these industries to define precise requirements or set priorities; and they strongly recommended that additional advice be sought from knowledgeable members of those industries before the final plan is formulated.

The Panel concluded that in the OCS oil and gas area, the most pressing information needs are related to catastrophic oil spills and blowouts--particularly in the Arctic; determination of the effects of long-term, low-level, chronic oil pollution; and the development of bioassay techniques for on-site monitoring. In the deep seabed mining area, the highest priority needs were related to assessing the effects of the surface discharged sediment plume and the necessity for shunting the discharge below the euphotic zone. It is recommended that these areas be carefully reviewed to determine the timeliness and effectiveness of past and present programs to provide the needed information in these areas, and that the Federal Plan be designed to address the identified needs which are not now being met.

NEEDS AND PRIORITIES FOR RESEARCH AND DEVELOPMENT AND MONITORING

Relative Priority	Information Needed
	GENERAL INFORMATION NEEDS (Relating to All Mineral Resources Activities)
	• Biological Effects
	a) Determine long-term, low-level, chronic effects through several generations on the food chain and eventual impact on man, marine mammals, fish and birds
	b) Determine short-term, acute effects on fish, man, marine mammals and birds
	c) Determine impact on fisheries resulting from nearshore mineral extraction activities, including support services and waste disposal

Relative Priority	Information Needed
	d) Determine assimilative capacity of receiving waters for diluting and removing wastes and develop techniques for evaluation of assimilative capacity
	• Design of Information Gathering Programs
	a) Develop strategies for carrying out and accumulating meaningful data for ecosystem impact and monitoring studies with emphasis on providing predictive models
	b) Develop techniques and strategies for relating lab studies to field work. Emphasize field studies whenever possible to evaluate entire systems rather than isolated components
	c) Develop systems for making existing scientific information available in relevant and useful forms so that public, state and local concerned groups and decision makers can access usable information
	• Support Development
	a) Develop analytical instrumentation techniques and standards for cost effective, reliable trace metal and synthetic organic measurements
	b) Develop measurement and sampling strategies to obtain sufficient, relevant, high-quality data
	c) Develop materials and equipment testing concepts
	d) Develop improved understanding of materials sciences related to toxicity of antifoulants, coatings, sealants, corrosion products, metal dissolution and outgassing, etc.
	• Risk Analysis
	a) Develop risk analysis and procedures as tools for decision-making relative to environmental pollution. These techniques should include the potential for human error, social and economic factors, and evaluation of potential consequences for compromises considered

Relative Priority	Information Needed
	SPECIFIC INFORMATION NEEDS
	Oil and Gas
	• Catastrophic Oil Spills and Blowouts--
High	a) Develop reliable models for predicting oil spill trajectories
High	b) Develop techniques for rapid deployment of containment and cleanup capabilities
High	c) Evaluate the environmental acceptability of chemical dispersants for oil cleanup by considering: 1) Short- and long-term effects on ecosystems 2) Dispersants with minimal negative impact 3) Guidelines or criteria for selection of dispersants under various conditions
High	d) Develop standardized strategies and techniques for monitoring the environmental effects of spills so that ecological, social and economic information from different sites can be interrelated
High	e) Develop techniques for predicting the effects of spills on fisheries, particularly in the highly-productive Georges' Bank area, independent of natural fluctuations
	• Special Information Needs for Arctic Oil and Gas--
High	a) Determine the transport path and effect of spilled oil under ice, particularly as it accumulates in leads and brine ponds with potential effects on migrating marine mammals and birds
High	b) Develop the capability to stop blowouts immediately under adverse weather and ice conditions. If techniques for immediate capping cannot be developed so that blowouts can be capped before the winter ice pack moves in, techniques must be developed for capping blowouts under ice
Medium	c) Determine the strength of ice against grounded objects
	• Exploratory and Development Drilling--
Low	a) Determine the community-level effects of discharged drilling

Relative Priority	Information Needed
	muds and drill cuttings on (1) coral, (2) shellfish and shellfish spawning grounds, and (3) benthic organisms and community structure in the vicinity of drilling platforms
Low	b) Determine the transport path and fate of drilling muds and their chemical constituents discharged under various oceanographic conditions typical of Atlantic, Gulf of Mexico and Alaska lease areas: 1) Develop dispersion models including the effects of shunting to various depths 2) Determine uptake and biomagnification in food chain organisms 3) Determine toxicity of chemicals used in drilling muds
Low	c) Evaluate alternative disposal methods for drilling muds and drill cuttings considering: 1) Storage and transport from drill site 2) Technologies and need for reconditioning or cleaning muds 3) Onshore disposal
Low	d) Determine fate and effects of residual chlorine in cooling water
	• Production--
Medium	a) Determine chemical and biological effects of structure placement
Medium	b) Determine long-term effects of brine discharges and small chronic spills
Low	c) Evaluate need for on-facility deck drainage and brine treatment in sensitive areas
Low	d) Determine the fate and effect of vented gas
	• Transportation--
Medium	a) Assess the environmental impact of pipeline construction on beaches and wetlands and the resulting disruption of biological communities
	• General--
High	a) Determine the effects of long-term, low-level chronic pollution from spills, releases, transportation, and production on: 1) highly productive estuaries and wetlands 2) highly productive fishing areas such as Georges' Bank

Relative Priority	Information Needed
High	b) Develop predictive models for long-term impact on food chain and higher organisms
High	c) Develop bioassay techniques and identify test organisms for *in-situ* monitoring
Medium	d) Determine appropriate information for geological considerations prior to leasing: 1) geological hazards 2) fault recurrance 3) sediment instability 4) permafrost levels 5) ice gouging 6) sedimentary processes on sea floor
Low	e) Determine the relative importance of the bubble burst process in transferring pollutants to the air
	Deep Seabed Mining
	• Surface and Water Column Effects--
High	a) Determine the fate and effects of surface discharged sediments: 1) characterization of particulate material with respect to size distribution and chemistry 2) determination of physical distribution of sediments with time 3) determination of possible pathways allowing bioaccumulation or incorporation into food chain of trace metals 4) determination of effect of discharge on photosynthesis, ingestion by fish and zooplankton
High	b) Evaluate necessity for shunting discharge below euphotic zone
Medium	c) Develop *in-situ* bioassay techniques for use in the water column
	• Benthic Effects--
Medium	a) Determine the biological significance of abyssal benthic environments, and the sensitivity of benthic biota to mining activities 1) obtain inventory of organisms disturbed by dredge 2) determine impact of dredge on benthic organisms, i.e., masceration, covering by sediment, having food supply covered by sediment 3) determine recolonization rate of benthic biota

Relative Priority	Information Needed
	b) Define physical area disturbed by the dredge 1) depth of penetration 2) sweep efficiency c) Define geological significance and sensitivity of abyssal benthic environments d) Develop instrumentation for better sampling and measurement in the deep ocean environment e) Develop <u>in-situ</u> bioassay techniques
Medium	• Processing-- a) Define viable processing options and identify the chemical and physical properties of the processing wastes b) Determine fate and effect of processing wastes disposed of on land and at sea
Medium	• Overall Concerns-- a) Develop predictive models considering ecologic, social and economic factors for the long-term global effects of commercial-scale mining activities on the marine environment
	<u>Sand and Gravel Mining</u>
	• Determine Generic Dredging Effects in Coastal Areas-- a) Characterize offshore sediment dynamics for deposits of economic importance b) Determine effects of mining on beach stability c) Develop and refine sediment dispersion models to predict discharge plume advection and dispersion

Relative Priority	Information Needed
	• Assess Potential Effects of Dredging-- a) Characterize toxic and nutrient materials in sediment b) Determine effects of toxic materials on biota impacted c) Determine effect of high-suspended solids concentrating on plankton, benthic organisms, habitat destruction
	• Determine Impact Resulting From Onshore Storage of Recovered Minerals--Leachates, Etc.--
	<u>Fresh Water Extraction: Desalination</u>
	• Evaluate Air Pollution Consequences of Evaporation--
	• Evaluate Consequences of Dike Failure Releasing Large Amounts of Brine--
	• Evaluate Alternatives for Salt Residue Disposal--
	<u>Salt Dome Extraction</u>
	• Determine Effects on Marine Organisms of Concentrated Brine Discharges--

SECTION 9

COASTAL DEVELOPMENT AND RECREATION

PANEL REPORT

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INTRODUCTION

The Coastal Deavelopment and Recreation Panel agreed that the following uses of the coastal zone are of interest and should be further considered within the scope of their discussions:

- Beaches and recreational uses
- Industrial and commercial uses
- Urban uses
- Recreational development
- Agriculture and silviculture

The Panel agreed that the following were major considerations and warranted development of a matrix for discussion (Table 1):

- Point sources of pollution
- Non-point sources of pollution
- Habitat alteration
- Water diversion
- Shore stability
- Facility siting

Pollutant sources associated with the first five categories and the significance of each of these in different United States coastal regions are shown in Table 2.

The Panel discussed regulatory officials and the decision chain; and the following elements were mentioned:

- EPA-NPDES permitting process
- Corps of Engineers - Dredge and Fill permits
- Land and water use decision-makers
  - coastal zone programs
  - local governments
- Federal land managers
- Financial assistance and development programs
- Judiciary

Two principal limiting factors in the decision process were identified; i.e., inadequate time for research after issues arise, and inadequate use of information in the decision process. Possible approaches to solving the problem of inadequate lead time for research are:

- Conduct research in anticipation of an issue
- Delay making a decision on an issue until adequate information is available

TABLE 1. MODEL MATRIX OF THE COASTAL DEVELOPMENT AND RECREATION PANEL FOR THEIR DISCUSSIONS OF INFORMATION NEEDS

Types of Information / Significant Activities in Coastal Zone	Scientific Data & Info	Technology	Economic Matters	Social and Institutional
1. Point Sources of Pollution Contamination				
2. Non-Point Sources of Pollution				
3. Habitat Alteration and Destruction				
4. Water Diversion				
5. Shore Stability				
6. Siting				

TABLE 2. SIGNIFICANT POLLUTANT SOURCES IN COASTAL REGIONS OF THE UNITED STATES

POLLUTANT SOURCES	REGIONS: North Atlantic	South Atlantic	Gulf of Mexico	Great Lakes	California	Pacific Northwest	Alaska	Pacific Islands
Municipal Outfalls	x	x		x	x	x		
Industrial Outfalls	x	x	x	x	x	x		
Urban Runoff	x	x	x	x	x	x		
Agricultural Runoff	x	x	x	x	x	x		x
Dredging Operations/Spoil Disposal		x	x					
Electric Power Generation	x	x	x	x	x	x		x
Nearshore Mineral Mining			x		x	x		
Nearshore Oil & Gas Development	x		x		x		x	
Port Operations/Tanker Discharges	x	x	x	x	x	x	x	
Recreational Activities	x	x	x	x	x	x		x

- Conduct generic research that will be useful for specific decisions

Environmental Impact Statements, information from NPDES and other permit applications and scientific government expertise should be relied on more in the decision-making process.

SPECIFIC NEEDS BY ACTIVITY AND TYPE OF INFORMATION

The Panel identified six general activities in the coastal zone and four general types of information for the model matrix in Table 1. This section lists specific research, development and monitoring needs for the combinations of activities and information types shown.

Scientific Data, Information and Technology

Point Sources of Pollutant Contamination--
Point sources of pollution in the coastal zone need to be inventoried for the following:

- Domestic wastewater treatment plants
- Industrial discharges
- Septic system cleaners and other home products
- Landfill leachate
- Energy facilities
- Nearshore and offshore drilling and mining
- Spills of oil and other hazardous materials

Wastewater effluents need to be sampled and analyzed for:

- Coliform bacteria
- Oxygen-demanding substances
- Nutrients (nitrogen)
- Heavy metals
- Microorganisms
- Suspended solids
- Others: virus, sediments
- Synthetic organics

Models for transport of pollutants to marine waters via the ocean and groundwater underflow need to be developed. Data bases for existing geologic and meteorologic conditions are needed for these models; data needs include:

- Rock or sediment-forming land mass onshore and offshore
- Surface water and groundwater inventories
- Erosion/deposition patterns
- Non-wind forces affecting currents
- Meteorologic data for nearshore current patterns throughout water column including:
  - wind forces
  - temperature
  - other local factors which create, accelerate or decelerate currents

Ecosystems of affected areas need to be identified and described. Habitat requirements of potentially affected species--i.e., food chain, reproductive behavior, etc.--should be delineated, as should the sensitivity of species to pollutants and the regenerative capability of ecosystems.

Non-point Sources of Pollution--
Non-point sources of pollution in the coastal zone need to be inventoried for the following:

- Stormwater runoff
- Animal wastes
- Cesspools and septic tanks
- Agricultural runoff
- Boat discharges
- Construction, site work activities
- Sand and gravel mining
- Rainwater
- Leakage from sewer systems
- Viruses in aquatic systems

The Panel recognized that obtaining reliable data on viruses is hampered by:

- Sampling difficulty
- Lack of standard methods for detection and identification of species
- Lack of epidemiological data concerning waterborne transmission of the many viral groups.

The types of pollutants in need of identification for non-point sources are:

- Coliform bacteria
- Nutrients
- Heavy metals
- Suspended solids
- Pesticides
- Fertilizers
- Pathogens
- Oil and grease

Models for transport of pollutants need to be developed for:

- Groundwater flow to marine waters
- Filtration through soils and uptake in plants
- Hydrologic cycle: precipitation, evapotranspiration, recharge to groundwater, runoff
- Ocean transport (see Point Source Section)
- Nearshore transport--flushing action of bays and estuaries
- Coastal - ocean exchange

Ecosystems of affected areas need to be identified and described. Habitat requirements of threatened species and their sensitivity to pollutants should be delineated. The regenerative capability of ecosystems needs more research.

Habitat Alteration and Destruction--

Two types of habitat alterations with different research needs have been identified: wetlands and offshore habitat alterations.

Wetland habitat alteration--Potential sources need to be inventoried; examples are:

- Filling of wetland areas for the siting of residential, commercial or industrial development
- Dredging and spoil operations, channelization, creation of new inlets, pipeline construction, bulkheading
- Inland water diversion projects affecting stream flow into marshes, bays and estuaries; i.e., stream augmentation, irrigation
- Thermal pollution by power plants

The following direct impacts of the alterations should be identified:

- Loss of wetland area, loss of habitat, loss of storm absorptive capacity, loss of filter capacity
- Alteration of salinity regime
- Alteration of water levels, construction of nutrients, chemicals, etc.
- Alteration of temperatures
- Behavioral alteration of species; i.e., destruction of nesting habits due to pipeline construction, etc.

Transport model and ecosystem-effect research needs are the same as those for non-point pollution sources.

Alteration of offshore habitat--Potential sources of offshore habitat alteration need to be inventoried. These include:

- Artificial islands and reefs
- Floating power plants
- Oil rigs and production platforms

Direct impacts of alterations need to be, identified and located; specific examples are:

- Changed current patterns
- Loss of habitat space, spawning and feeding areas
- Artificial reef effects on the distribution of species
- Effects on migratory patterns of marine species

Water Diversion--

Water diversion activities in the coastal zone and the attendant research needs are discussed in the habitat alteration and shore stability sections.

Shore Stability--

Structures used to stabilize a shoreline need to be identified and described; examples include groins, piers, jetties, seawalls, riprap, revetments, bulkheading, breakwaters, construction on or in front of primary dunes, structure on shore bluff faces. The impacts of off-the-road vehicles on shorelines need to be determined. Attention to shore drainage patterns is needed.

The direct impacts of any alterations on normal coastal erosion, as well as instability and the loss of storm absorptive capacity, need to be identified.

Techniques are needed to describe the effects of currents and waves on coastal beaches and bluffs and to estimate rates of erosion. Interactions of erosion, shore structures, and use-patterns need to be determined. Data bases for existing geological, meteorological and biological conditions of shorelines are needed; specific examples are:

- Surface and subsurface characteristics of rocks and sediments comprising shore and offshore ground mass, including sand bars or reefs
- Dynamic characteristics of along-shore currents and waves related to beaches, bars, erosion
- Rain/snow precipitation patterns
- Wind patterns
- Wind-generated waves and currents
- Vegetation - providing protection from wind and rain

Ecosystem-effects needs for shore stability activities in the coastal zone are the same as those for habitat alteration needs

Siting--

The scientific data information and technology requirements relative to siting are reflected in the following sections:

- Point sources of pollution contamination
- Non-point sources of pollution contamination
- Habitat alteration and destruction

The Panel recognized the visual aesthetics of a power plant and other types of facilities, but did not consider the issue in detail.

Economic Matters

Coastal and marine environments are centers for many services which have no market price, but which, nevertheless, have economic value. To make benefit-cost comparisons, consistent economic values for these services are needed.

A basic question is: What are the costs of pollution compared with the costs and benefits of pollution control?

The types of unpriced environmental services that can be affected by point source pollution are:

- Recreation
  - beach activities
  - fishing
  - boating
- Human Life Support
  - clean air for breathing
  - clean water for drinking
- Aesthetic Appreciation
- Marketable Goods
  - fisheries resources

Value must also be attached to our desire to maintain certain aspects of the environment in their current state, for instance, wildlife species and wetlands. In order to determine whether any or all of the above categories would be impacted severely by pollution the following questions need to be answered:

- What environmental services are currently being used in a coastal area?
- Are there potential future uses (i.e., aquaculture) which would be precluded or made less efficient by the impact in question?

Social and Institutional

Basic research questions for all six uses/activities in the coastal zone include:

- What are the current legal and institutional mechanisms for dealing with pollution and impacts from these uses/activities? Example mechanisms for point sources of pollution are EPA-NPDES permitting system and land and water use decision officials (coastal zone program, local governments, Federal land management programs and financial assistance development programs). Examples for habitat alteration and destruction are wetlands legislation, coastal-zone management legislation, local land-use legislation, and Estuarine Sanctuaries Program
- In economic terms, regulation attempts derive the greatest social value from our coastal and marine resources. To what extent do the current regulating mechanisms achieve this, i.e., in appropriate regulations, monitoring, programs, enforcement?
- What new institutional mechanisms might be proposed to help achieve a more socially valuable combination of uses of coastal and marine resources? For example, the current institutions cannot deal with non-point source pollution.
- How do these affect research and data collection efforts?

CONCLUSIONS AND RECOMMENDATIONS

Physical, Biological and Chemical Research Needs

Pollutant Discharges--

Methods need to be developed for estimating existing and future pollutant discharges (particularly synthetic organics, heavy metals and fossil fuel compounds) by region from the following prioritized sources:

Priority	Source
High	Municipal outfalls
High	Industrial outfalls
High	Agricultural runoff
High	Urban runoff
High	Dredging operations and spoils disposal
Medium	Electric power generation
Medium	Nearshore mineral mining
Medium	Nearshore oil and gas operations
Medium	Port operations and operational tanker discharges
Low	Recreational activities

Regional significance of these pollutants is presented in Table 2.

Transport and Fate--

Empirical and analytical techniques (including models of physical, chemical and biological processes) that relate pollutant discharges from multiple sources to ambient conditions and exposures are needed. Prioritized needs for transport and fate models are shown below:

Priority	Model
High	Models for synthetic organics
High	Models of heavy metals, particularly organometallic speciation
Medium	Models of fossil fuel compounds
Medium	Models of radioactive materials
Medium	Models of microorganisms

A state-of-the-art assessment of transport and fate models, uncertainties involved in their use, and a survey of applications would be particularly helpful to coastal zone managers.

Effects--

Information on the effects of pollutants from all listed activities and of ambient environmental quality on human health and welfare, marine organisms, and marine ecosystems is needed. Particular emphasis is placed on low-level, long-term, chronic, cumulative effects. Specific research needs and their priorities are:

Priority	Research Need
High	Determination of human health effects of microorganisms and synthetic organics entering the marine food chain
High	Evaluation of indicator organisms and test procedures for detecting microorganisms, fossil fuel compounds, heavy metals and synthetic organics in coastal waters
Medium	Determination of the relationship between microorganisms (primarily from sewage sludge and dredged

Priority	Research Need
	spoils) and recreational water users
Medium	Determination of the relationship between physical modifications (e.g., dredging, channelization) of the coastal environment and marine ecosystems and processes
Medium	Determination of the effects of altered hydrologic regimes (e.g., salinity changes) on coastal ecosystems and processes
Medium	Evaluation of the reversibility of pollution-related changes to coastal ecosystems and processes
Medium	Determination of the ecosystem effects of oil spills and operational discharges in Arctic environments
Low	Identification of particularly pollution-sensitive ecosystem components
Low	Determination of the variability of natural and polluted ecosystem by region, space and time, identifying relevant scales of these processes.

Economic and Institutional Research Needs

Economics--

Estimates of the costs, benefits and risks associated with potential actions is of direct value to management decision-making and to devising alternative pollution control strategies. Costs of alternative pollution control strategies, the distribution of costs geographically over time and among demographic groups, and the benefits of goods and services whose production might be subject to control for environmental purposes must be studied. Specific needs are:

- Development of methods for estimating the value of environmental services of the coastal region, e.g., as a living resource habitat, as a receptacle for waste disposal, as a recreation resource, as an aesthetic resource, etc.
- Development of economic damage functions relating time and spatial patterns of ambient concentrations of pollutants to resulting impacts on receptors--humans, marine organisms--in physical, biological and economic terms (the latter typically unavailable, but critical for pollution control purposes). Examples include amounts of oil on beaches related to losses in recreational values or levels of pesticides in coastal waters related to losses in wetland or fisheries values
- Development of methods for assessing the costs of pollution control versus benefits derived; examples include: the costs of reducing the probability of tanker oil spills relative to the recreational benefits derived or the costs of reducing ocean dumping discharges compared to the fishing benefits
- Refinement of methods to predict spatial and temporal distribution of both land-based and offshore economic activities in coastal regions, particularly mineral development, energy development and production, and recreation
- Refinement of methods to predict secondary impacts (physical, biological and economic) of major coastal and offshore development projects (e.g., deepwater ports, LNG facilities, onshore processing facilities required for deep ocean mining). For example, the special problems that arise when large-scale development takes place in a relatively undeveloped area (e.g., Alaska) need to be assessed
- Determination of the economic incentives which can be used to ensure rational development of ocean resources. For example, economic incentives (e.g., marketable discharge rights, effluent charges) that minimize coastal pollution need to be discovered, and the administrative costs of using economic incentives versus more traditional regulatory tools (permits, licenses) need to be assessed

Institutions--

Institutional research must have two distinct orientations: (1) technology transfer by decision-making institutions and agencies is needed; and (2) analyses of the effectiveness of decision-making institutions and their programs are needed. The Panel cited the following specific needs and priorities:

- Pollution Management models structured so that legislators and public executives get the information they desire, i.e., information on effects, costs and benefits--and their distribution relative to constituent groups of interest. What model structures facilitate communications among decision-makers?
- Ocean pollution decision-making systems which are assessed from the standpoint of their ability to analyze each decision-maker's attitude toward risk. What investments in information development would narrow the range of uncertainty for the whole set of decisions to be made?
- Effective processes for making fundamental decisions about levels of ocean pollution that balance risks with traditional goals of economic welfare. What problems exist with legislative structures, the changing nature of administrative laws, the role of the courts in reviewing actions of executive agencies, the jurisdictional level at which pollution control decisions are made?
- Documentation on the performance of existing institutions in terms of addressing issues, e.g., regional fisheries management councils, state CZM

programs, state water pollution control agencies

- Analyses of the effectiveness and costs (both direct and indirect) of existing pollution control programs, e.g., dredging permits programs, state NPDES programs, wetland protection programs. How is performance of these programs measured? How is enforcement carried out? What sanctions exist for violations?
- Investigations of new institutional structures (or modifications in existing ones) that will enable better management of coastal and marine resources

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