

NATIONAL PRIORITIES IN MARINE POLLUTION

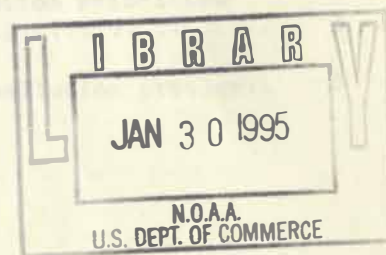
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1988

February 1988



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Office of the Chief Scientist
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1. INTRODUCTION

The National Ocean Pollution Program Office (NOPPO) of the National Oceanic and Atmospheric Administration is required by the National Ocean Pollution Planning Act (PL 95-273) to make recommendations on the federal program in marine pollution research, development, and monitoring, and promote interagency cooperation in these areas. The first step in evaluating the Federal effort in ocean pollution research is to identify the marine pollution needs and problems that are facing the nation. To broaden the knowledge base used in identifying and prioritizing these issues, NOPPO has consulted pollution experts outside as well as within the Federal Government using the "Priorities Worksheet for National Marine Pollution Problems and Needs." The worksheet was mailed out in January 1987 to over 250 participants representing the following sectors of the ocean community: the Legislative and Executive Branches of the Federal Government, conservation groups, sport and commercial fisheries, offshore petroleum and mining interests, the ports and recreation industries, state and regional governments, and researchers in the marine pollution field. The list of participants was developed with the assistance of a steering committee. The committee included representatives from the following agencies and organizations: the U.S. Environmental Protection Agency's Office of Marine and Estuarine Protection, House Merchant Marine and Fisheries Committee (U.S. Congress), Coastal States Organization, Association of State and Interstate Water Pollution Control Administrators, Natural Resources Defense Council, American Petroleum Institute, American Fisheries Society, University of North Carolina's Sea Grant Program, and the Oceanic Society.

2. SURVEY METHOD

The Priorities Worksheet was divided into four sections. Part I involved ranking the importance of 5 criteria, developed by NMPPPO, for rating 83 marine pollution problems in Part II. The five criteria are shown in Table 1. These criteria are based on those used at an earlier Workshop on National Marine Pollution Research and Monitoring Issues, held in June, 1984, where a similar exercise was performed (Harvey and Zacherle, 1985; Leschine, 1985; Robertson and Harvey, 1985). However, two criteria from the previous workshop were subsumed into the five used for the 1987 Priorities Worksheet. Analysis of the 1984 workshop results demonstrated that these two criteria were not significantly different from the others with regard to their value in rating the problems.

Participants assigned each criterion a rank between one and five, with one indicating the highest significance. Participants were allowed to give more than one criterion the same rank if they felt it was of equal importance. Space was left on the worksheet, below the criteria listing, to allow for addition and ranking of any other important criteria which the participant felt should be considered. The purpose of Part I of the worksheet was primarily to encourage the participants to think about the criteria that they use in determining the importance of marine pollution problems.

Table 1: Criteria Used in the 1987 National Marine Pollution Priorities Worksheet

- 1) How significant is this problem to human health? e.g.,
 - contamination of food resources leading to exposure to harmful levels of pollutants
 - possible threat to drinking water supplies
 - health risks associated with swimming in polluted waters
- 2) How significant is this problem to the integrity of marine or Great Lakes ecosystems (including fish and shellfish)? e.g.,
 - changes in levels of primary production
 - changes in species composition and diversity
 - alterations in food webs
- 3) How economically significant is this problem to commercial users and producers of these resources? e.g.,
 - commercial finfish & shellfish industries
 - travel industry, tourism, marine resort industry
 - boating, sport fishing, and other marine recreational industries
- 4) What is the social significance of this issue (defined by impacts on recreational or aesthetic values) to individual users of the marine environment? e.g.
 - vacationers
 - boaters, fishermen, divers, etc.
 - such passive users as wildlife watchers, sightseers and photographers
- 5) Is the severity of this problem likely to increase or decrease in the next five years? e.g., as a result of
 - new laws/regulations which increase/decrease the activity
 - changes in commercial and industrial practices which increase/decrease impact of activity

Part II of the Worksheet, the rating of each marine pollution problem with respect to "overall significance," involved assigning a number between one and five to each problem. This rating was to be based on the five criteria mentioned in Part I. Two examples of hypothetical ratings were given to assist the participant. The listing of the problems was organized using three levels of detail:

Roman numerals: 14 major groupings of polluting activities
Letters: 33 subdivisions of polluting activities
Arabic numerals: 83 marine pollution problems resulting from the activities.

This organization was designed to help clarify exactly what was to be rated and place the rating at the problem level rather than at the activity level, in an attempt to alleviate the confusion of rating effects versus activities versus problems which occurred at the last workshop. The first page of Part II of the Worksheet is shown in Figure 1 as an illustration.

In Part III of the Worksheet, each participant selected the six of the 33 subdivisions of polluting activities which he or felt were the most important and the six which were the least important national marine pollution problems. This section was an effort to examine the value of our organizational scheme, i.e., whether it was necessary to go down to the problem level or whether the same results would have been obtained by considering subdivisions of activities.

Part IV of the Worksheet was a "Participant Information Sheet" on which participants indicated such information as their profession, their areas of expertise in marine pollution, and the region which their views represent.

3. RESULTS

Respondents

Of 255 Worksheets that were sent out, 145 were returned, representing a 57% response rate. Of these responses, the sector affiliation of the respondent was known in 127 cases. Results of the analysis of sector response is shown in Table 2. State and local government were grouped together in this analysis. The "academia" group includes scientists involved in objective environmental studies or assessments performed under contract (i.e., independent consulting) as well as university scientists. Other sectors included the Federal Executive and Legislative Branches, the environmental interest sector, and the ocean industries of fishing, mining, oil and gas development, ports, and recreation.

Criteria

The criterion ranking results were similar to those obtained in 1984; the effect of pollution on human health was ranked the most important, while the effect on ecosystem integrity was ranked a close second. Figure 2 gives the mean rankings of the various criteria. There was not much difference in the rankings given to the last three criteria.

Figure 1: Sample page from Section II of the Priorities Worksheet.

RATING		MARINE POLLUTION PROBLEMS _e
LOW	HIGH	
(Circle one)		

I. DISPOSAL OF SEWAGE EFFLUENTS AND SLUDGE_e

A) Ocean Dumping of Sewage Sludge (Deepwater Dumpsite 106)_e

- | | | | | | |
|---|---|---|---|---|--|
| 1 | 2 | 3 | 4 | 5 | 1 - Input of sewage-associated pathogene |
| 1 | 2 | 3 | 4 | 5 | 2 - Input of sewage-associated toxicant _e |
| 1 | 2 | 3 | 4 | 5 | 3 - Input of persistent waste (e.g., accumulation of plastics on beaches and in sensitive habitats) _e |
| 1 | 2 | 3 | 4 | 5 | 4 - Input of nutrients (eutrophication - e.g., nitrogen & phosphorous) _e |

B) Pipeline Effluents of Municipal Wastewater_e

- | | | | | | |
|---|---|---|---|---|--|
| 1 | 2 | 3 | 4 | 5 | 5 - Input of sewage-associated pathogene |
| 1 | 2 | 3 | 4 | 5 | 6 - Input of sewage-associated toxicant _e |
| 1 | 2 | 3 | 4 | 5 | 7 - Input of persistent waste _e |
| 1 | 2 | 3 | 4 | 5 | 8 - Input of nutrients (eutrophication) _e |

C) Pipeline Discharge of Sewage Sludge (e.g., Boston & L.A. County)_e

- | | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 9 - Input of sewage-associated pathogene |
| 1 | 2 | 3 | 4 | 5 | 10 - Input of sewage-associated toxicant _e |
| 1 | 2 | 3 | 4 | 5 | 11 - Input of persistent waste _e |
| 1 | 2 | 3 | 4 | 5 | 12 - Input of nutrients (eutrophication) _e |

II. DISPOSAL OF INDUSTRIAL WASTE_e

D) Ocean Dumping of Industrial Wastes_e

- | | | | | | |
|---|---|---|---|---|--|
| 1 | 2 | 3 | 4 | 5 | 13 - Dumping of wastes from chemical plant processes _e |
| 1 | 2 | 3 | 4 | 5 | 14 - Dumping of flue gas desulfurization sludges (from coal-burning electric utilities and industrial coal-fired burners) _e |
| 1 | 2 | 3 | 4 | 5 | 15 - Dumping of coal ash (from coal-burning electric utilities and industries) _e |

E) Pipeline Discharges_e

- | | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 16 - Discharges from industrial processes or waste treatment facilities directly into marine and Great Lakes waters |
| 1 | 2 | 3 | 4 | 5 | 17 - Discharges of industrial wastes into marine and Great Lakes waters via municipal waste treatment plant effluents |
| 1 | 2 | 3 | 4 | 5 | 18 - Input of thermal energy "waste" from power generating facilities |

F) Ocean Incineration of Chemical Waste Materials (e.g., PCB's)_e

- | | | | | | |
|---|---|---|---|---|--|
| 1 | 2 | 3 | 4 | 5 | 19 - Input of products of combustion (e.g., metals and hydrochloric acid) _e |
| 1 | 2 | 3 | 4 | 5 | 20 - Input of residuals from incomplete combustion (e.g., organics) _e |
| 1 | 2 | 3 | 4 | 5 | 21 - Input of contaminants due to accidental spillage during transportation, handling, and storage |

Table 2: Participants in the National Marine Pollution Priorities Worksheet Study

SECTOR	# MAILED	# RETURNED	% RESPONSE
Federal Executive Branch	48	34	71%
Scientists		20	
Managers		14	
Federal Legislative Branch	22	6	27%
State and Local Government	41	25	61%
Environmental Interest	37	18	49%
Academia	36	15	42%
Ocean Industry	71	29	41%
Minerals		16	
Fishing		9	
Port Authorities*		2	
Recreation		2	
Sector Unknown		18	
Total	255	145	57% overall

*One of the port authority responses represents a composite of 11 responses.

Figure 2: Mean ranking of criteria used in study. Participants could rank the criteria from 1 (highest significance) to 5 (lowest significance.)

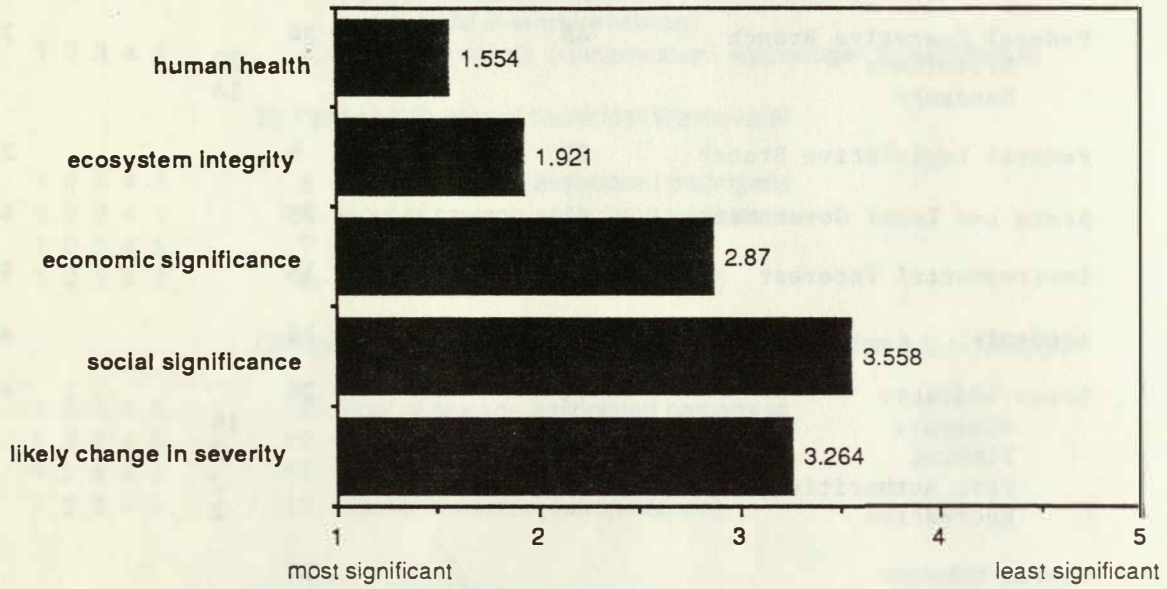


Table 3: Overall and sector mean scores for each pollution problem. Overall mean is calculated by averaging all responses for that issue. Sector mean is calculated by averaging within each sector, then averaging the sectors together; this gives each sector equal weight, regardless of the number of respondents in that sector. The 83 issues are ordered by their sector mean rating, from highest to lowest priority.

rank	Marine Pollution Problem	overall mean	sector mean	rank	Marine Pollution Problem	overall mean	sector mean
1	Pipeline Sludge Disposal/Toxicants	4.23	4.20	42	Sludge Dumping/Persistent Waste	3.12	3.16
2	Agricultural NPS/Pesticides	4.17	4.19	43	Atmospheric Deposition/Heavy Metals	3.22	3.15
3	Direct Industrial Pipeline Discharges	4.25	4.15	44	Pipeline Sludge Disp./Persistent Waste	3.28	3.15
4	Wetland Modific./Coastal Development	4.08	4.09	45	Sand, Gravel, Phosphate Mining/Physical	3.20	3.15
5	Sewage Effluent Discharge/Toxicants	4.17	4.08	46	Coal & Metal Mining/Metals	3.19	3.15
6	Habitat Modific./Coastal Development	4.10	4.07	47	Urban & Suburban Runoff/Debris, Sediment	3.12	3.13
7	Urban & Suburban Runoff/Metals	3.84	3.89	48	OCS Oil & Gas/Petroleum Hydrocarbons	3.04	3.10
8	Spills of Hazardous Chemicals	3.94	3.81	49	OCS Oil & Gas/Oil from Pipeline Breaks	3.12	3.06
9	Dredged Mat. Nearshore Disp./Contamin.	3.92	3.80	50	Vessel Operations/Oil from Tank Washing	3.03	3.04
10	Indirect Industrial Pipeline Discharges	3.86	3.78	51	Forestry NPS/Eroded Sediments	2.99	3.04
11	Agricultural NPS/Nutrients	3.70	3.78	52	Vessel Operations/Persistent Waste	3.03	3.03
12	Ocean Dumping/Chemical Wastes	3.91	3.75s	53	At-Sea Incineration/Residuals	3.09	2.96
13	Pipeline Sludge Disposal/Pathogens	3.74	3.68s	54	PMS Mining/Processing Discharges	3.02	2.96
14	Sewage Effluent Discharge/Pathogens	3.61	3.67	55	Ocean Dumping/Flue Gas Desulf. Sludge	3.04	2.95
15	Urban & Suburban Runoff/Pesticides	3.70	3.63s	56	OCS Oil & Gas/Oil from Vessel Accidents	2.97	2.94
16	Sewage Effluent Discharge/Nutrients	3.60	3.59s	57	Sand, Gravel, Phosphate Mining/Contamin.	3.10	2.91
17	Sludge Dumping/Toxicants	3.61	3.51s	58	Radionuclides/Low-Level Waste Dumping	2.85	2.84
18	Habitat Modification/Agriculture	3.52	3.48s	59	Sludge Dumping/Pathogens	2.82	2.83
19	Coastal Habitat Loss/Agriculture	3.54	3.47s	60	Fin, Shellfishing/Bottom Disruption	2.84	2.76
20	Pipeline Sludge Disposal/Nutrients	3.49	3.46	61	OCS Oil & Gas/Drilling Muds & Cuttings	2.65	2.71
21	Forestry NPS Pollution/Pesticides	3.46	3.43s	62	Vessel Operations/Path., Nutr., Chem.	2.84	2.70
22	Urban & Suburban Runoff/Pathogens	3.40	3.41s	63	Fin, Shellfishing/Discarded Nets, Traps	2.61	2.69
23	Drydock, Port & Marinas/Antifoulants	3.57	3.41s	64	Coal & Metal Mining/Radioactive Partic.	2.77	2.68
24	Atmospheric Deposition/S & N Oxides	3.40	3.40s	65	OCS Oil & Gas/Debris, Trash, Sewage	2.63	2.66
25	Urban & Suburban Runoff/Petroleum	3.37	3.39s	66	Ocean Dumping/Coal Ash	2.70	2.61
26	Prod.Agricultural NPS/Eroded Sediments	3.34	3.35s	67	Sludge Dumping/Nutrients	2.57	2.60
27	Tanker Accidents/Hydrocarbon Spills	3.49	3.35s	68	Dredged Mat. Offshore Dumping/Physical	2.68	2.60
28	Radionuclides/High-Level Waste Dumping	3.48	3.35s	69	At-Sea Incineration/Combustion Products	2.69	2.58
29	Urban & Suburban Runoff/Nutrients	3.34	3.33s	70	PMS Mining/Physical Alterations	2.65	2.58
30	At-Sea Incineration/Accidental Spills	3.41	3.33s	71	Mn Nodule Mining/Contaminated Sediments	2.67	2.52
31	Dredged Mat. Nearshore Disp./Physical	3.40	3.31s	72	Fin, Shellfishing/Persistent Debris	2.56	2.52
32	Atmospheric Deposition/Organics	3.44	3.30s	73	OTEC/Antifouling & Cleaning Agents	2.64	2.49
33	Coal & Metal Mining/Acids & Tailings	3.25	3.29s	74	PMS Mining/Associated Chemical Changes	2.59	2.47
34	Dredged Mat. Offshore Dump./Contaminants	3.49	3.29s	75	Mn Nodule Mining/Physical Alterations	2.56	2.46
35	Radioactive Waste/Pipeline Disposal	3.30	3.28s	76	Strategic Petrol. Reserve/Brine Sol'ns	2.44	2.46
36	OCS Oil & Gas/Crude from Well Blowout	3.22	3.25s	77	OCS Oil & Gas/Produced Waters	2.42	2.38
37	OCS Oil & Gas/Onshore Activities	3.24	3.25s	78	Thermal Waste Discharges/Power Plants	2.39	2.33
38	Sewage Effluent Discharge/Persistent	3.28	3.21s	79	Other Marine Energy/Tidal Regime Changes	2.33	2.32
39	Habitat Loss & Modification/Mining	3.34	3.21s	80	Fin, Shellfishing/Discarded By-Catch	2.22	2.12
40	Drydock, Port & Marinas/Petroleum	3.16	3.17	81	OTEC/Entrainment and Impingement	2.29	2.10
41	Agricultural NPS/Fecal Pathogens	3.20	3.17	82	OTEC/Vertical Displ. of Water Masses	2.06	2.04
				83	Other Marine Energy/Entrain. & Imping.	2.12	1.98

Figure 3: Comparison of mean issue scores for each sector compared with mean calculated by giving each sector one vote. Issues are ordered by their sector mean ratings (see Table 3.)

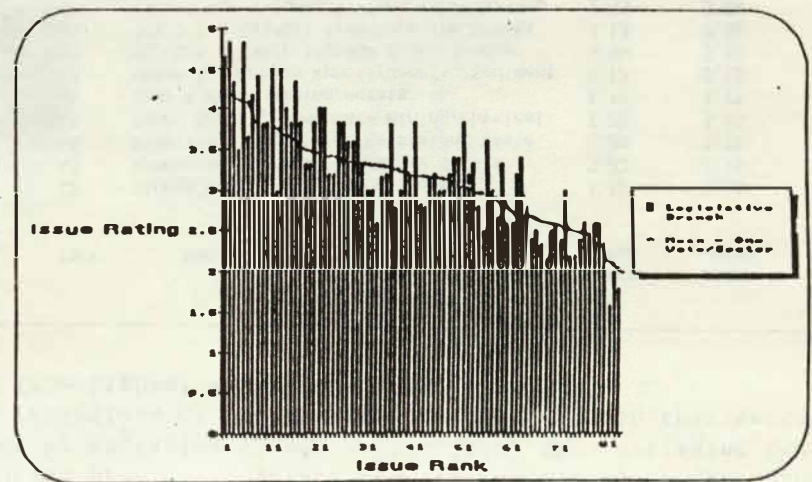
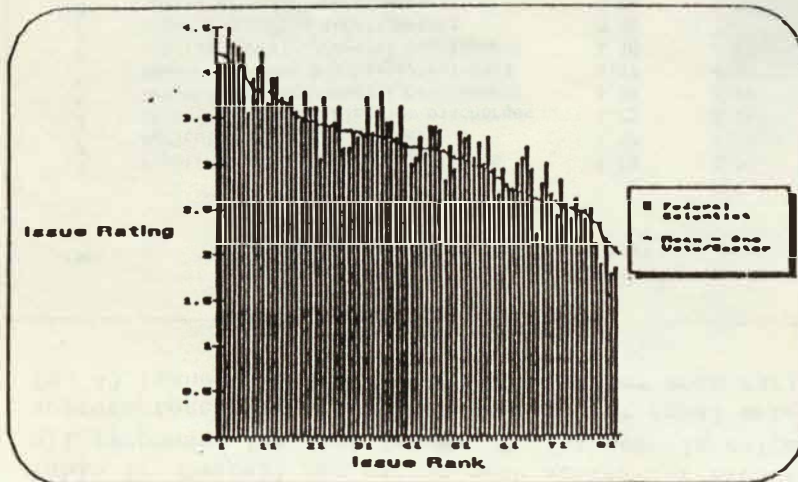
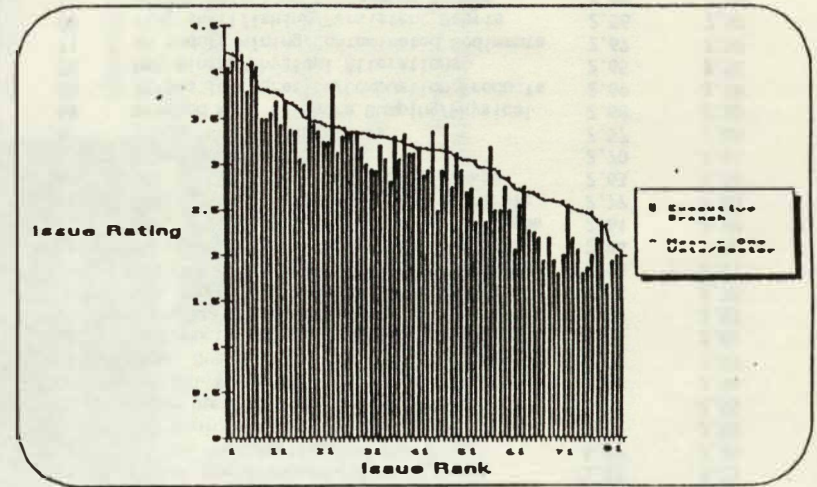
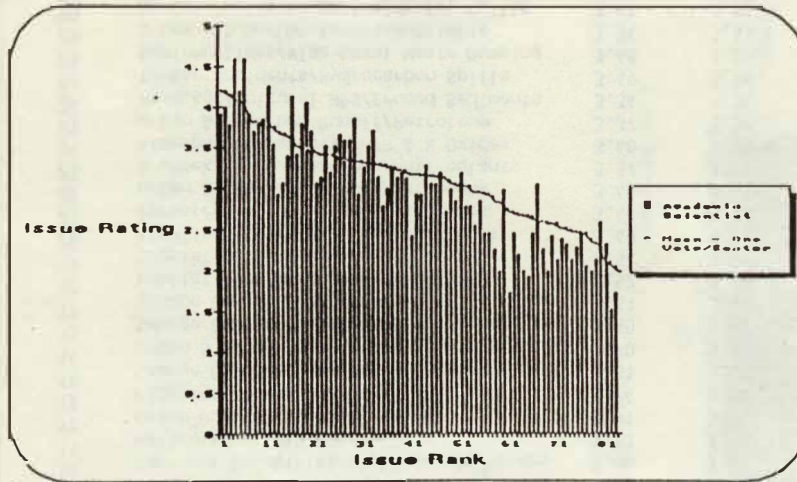
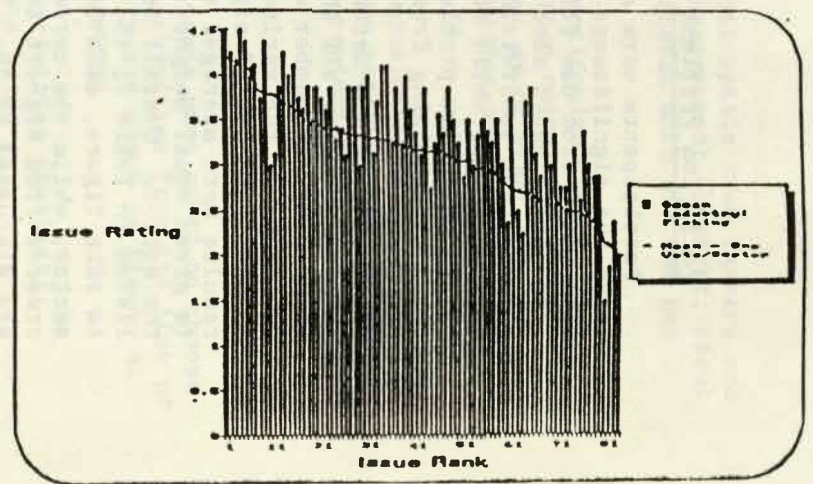
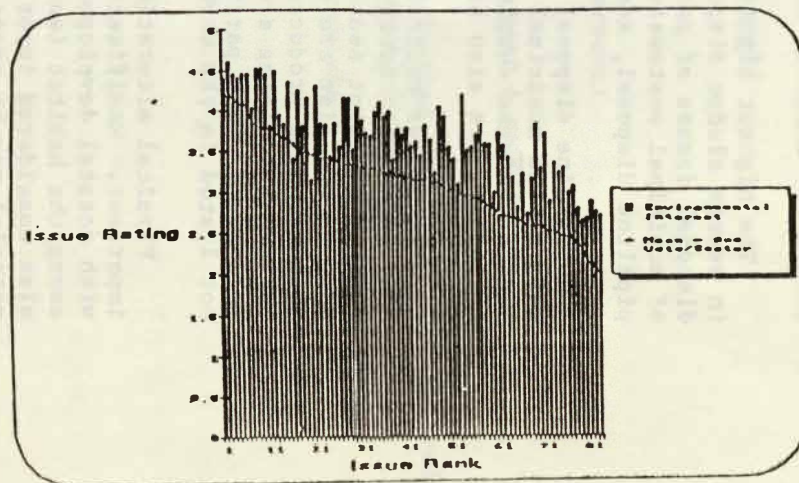
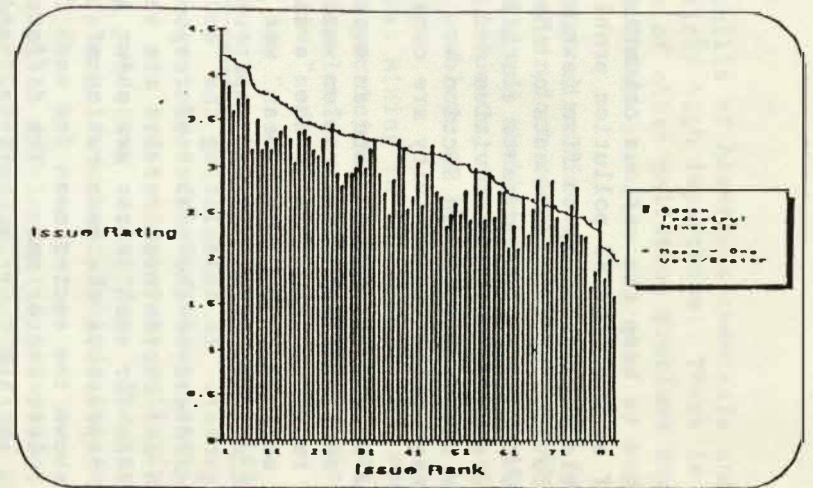
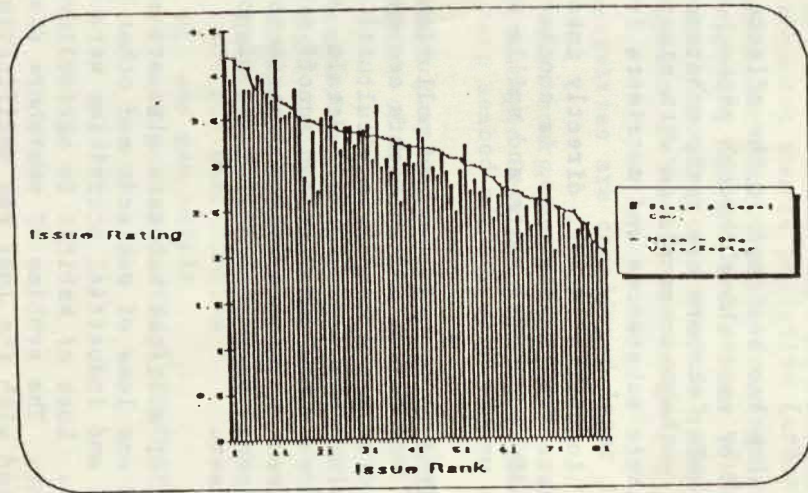


Figure 3 (continued)

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Pollution Problems

Participants were asked to keep the various criteria in mind while they rated the significance of each of the 83 pollution problems. The problems were rated from one (little significance) to five (extremely high significance). Some participants also provided optional comments on the polluting activities and fourteen subdivisions. Some of the comments clarified and explained the ranking given, while others added new subactivities and pollutants. Comments on the pollution problems are summarized in Section 4. In this section, the problems resulting from each polluting activity are considered together.

Two different methods were used to calculate an overall rating for each problem. First, all the responses for each problem were added and the total divided by the number of respondents. This is the "overall mean." To compare the views of the various sectors, the "sector mean" was calculated; the responses for each of eight sectors were averaged separately, and these eight results were averaged together. In calculating the "sector mean", each sector is given equal weight regardless of the number of respondents representing the sector. Overall mean and sector mean results are very similar. They are listed in Table 3; the means for each sector are shown graphically in Figure 3. In this figure, each bar represents the mean rating of that issue for that sector, while the curve shows the sector mean for each issue. The issues are ordered from highest to lowest sector mean. The differences between sectors are discussed below. The sectors "port authorities" and "recreation" were judged too small to be included in this analysis.

The highest significance was assigned to the effects of toxic substances in sewage sludge disposed of near shore through pipes. Other municipal waste disposal issues of particular concern are toxic substances from the discharge of municipal wastewater, pathogens associated with sludge and wastewater pipeline disposal, and toxic substances and nutrients from sludge dumping.

Pipeline disposal of industrial waste, directly into surface waters as well as via municipal waste treatment plants, is another problem of particular concern. Ocean dumping of industrial waste and spills during at-sea incineration activities are also high on the list.

Activities contributing to nonpoint source pollution were generally assigned high priority. Pesticides and nutrients are considered the most serious nonpoint source problems caused by agricultural activities; further down on the list are sediments and pathogens. Metals, pesticides, pathogens, and petroleum products from urban and suburban runoff are of concern. Silviculture and mining are seen as less important contributors to nonpoint source pollution. Many participants suggested additional nonpoint source pollutants not listed in the worksheet.

Physical alterations of critical habitats also are considered very important. Modification and loss of wetlands and other habitat associated with coastal development and industrial activities were rated most highly among the habitat issues. Loss of habitat to agricultural activities is also considered important. The problem of nearshore disposal of dredged material may be associated with the loss and modification of wetland habitat.

Accidental spills of hazardous chemicals and oil spills from tankers are considered of fairly high importance. There is disagreement, however, about the significance of other pollution problems associated with oil and gas development activities.

Moderately high significance was assigned to antifoulant agents from marina, port, and drydock operations. Pollution from commercial and recreational finfishing and shellfishing is not regarded as of great concern by most of the participants, nor are the effects of marine energy development seen as serious problems at the present time.

Marine mineral mining in the deep sea is not considered to be very important by the participants; nearshore mining was rated somewhat higher. The impact of dissolution mining from Strategic Petroleum Reserve operations is not considered a serious problem.

Most and Least Important Polluting Activities

In the last section of the Worksheet, participants were asked to choose the six most, and six least, important polluting activities from the list of 33 categories of polluting activities. The results are shown in Figure 4. Those selected as most important include the following:

- coastal development & industrial activities (habitat)
- pipeline disposal of municipal waste water
- pipeline disposal of industrial waste
- nonpoint source pollution (urban)
- nonpoint source pollution (agricultural)
- pipeline disposal of sewage sludge
- ocean dumping of industrial waste
- spills of hazardous materials.

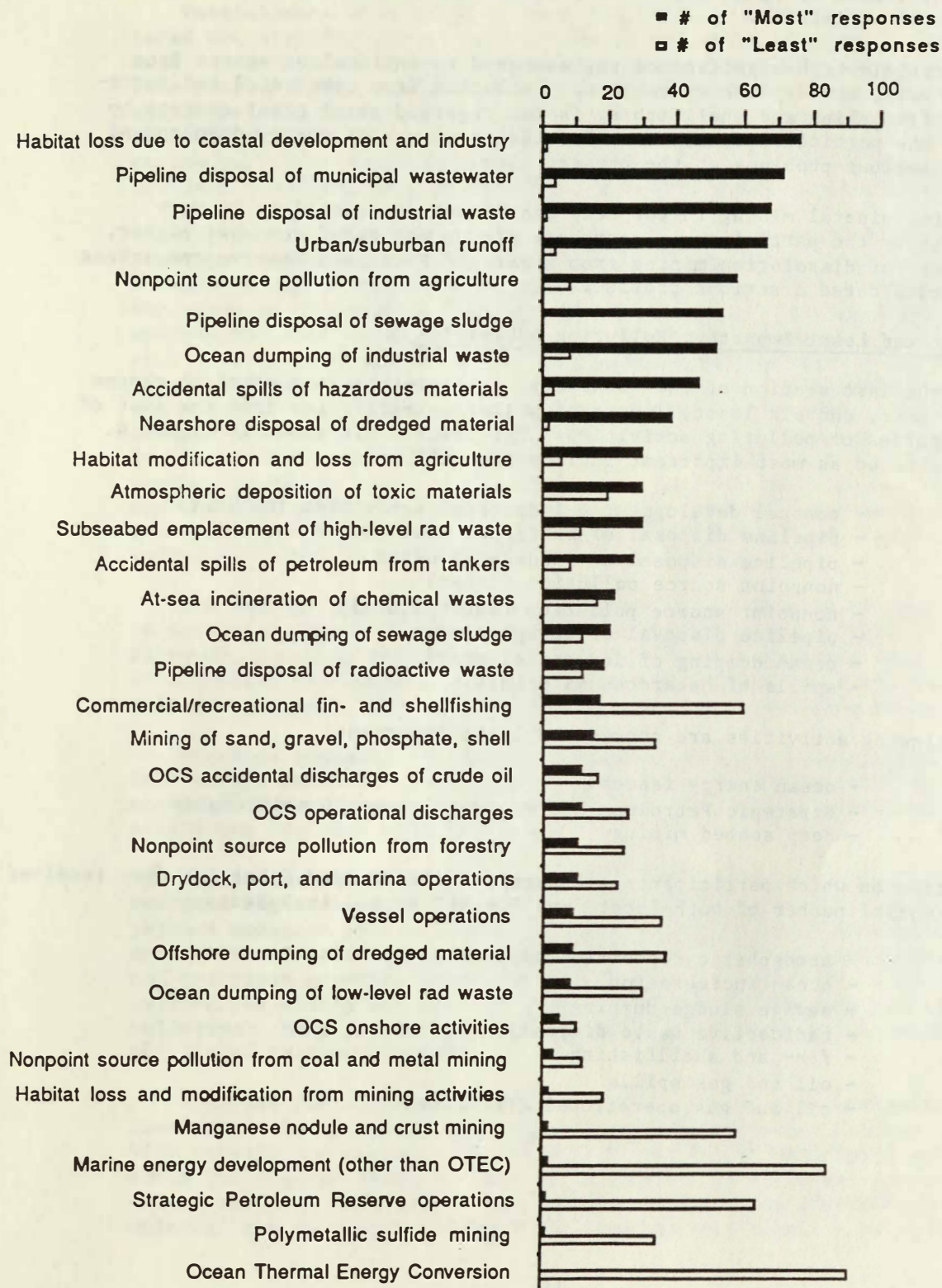
The following activities are considered least important:

- ocean energy issues
- Strategic Petroleum Reserve development & maintenance
- deep seabed mining

Activities on which participants are particularly divided (that is, they received a substantial number of both "most" and "least" votes) included:

- atmospheric deposition of toxic materials
- ocean incineration
- sewage sludge dumping
- radioactive waste disposal
- fin- and shellfishing
- oil and gas spills
- oil and gas operational discharges.

Figure 4: Most and least important polluting activities (results from Part III of Priorities Worksheet.) Activities are ordered according to the number of "Most Important" votes. Participants were allowed to select up to six "Most Important" and six "Least Important" polluting activities.



Sector Analysis

To compare the evaluations of the various sectors, the results for each each pollution problem have been compared to the sector mean. In the sector analysis, the Federal Executive Branch was divided into two groups, "Federal scientists," which includes practicing scientists employed by the Federal Government, and "Federal Executive," which includes managers and policy-makers. Oil and mining industries were combined into one group, the "minerals" sector. The sectors "port industry" and "recreation," with two responses each, were too small to be included in the sector analysis. In Figure 3, the results for various sectors are compared to the sector mean for each pollution problem.

The ratings given by the Federal scientists fall close to the sector mean curve. Academic scientists show larger differences from the mean, and consider most of the problems to be less important than does the group overall. They consider pathogens of relatively lower importance, and those pollution issues which involve nutrients of higher importance. Habitat loss and modification are also considered of particular significance by academics.

Members of the Federal Executive Branch tend to score problems lower than the sector mean. Relatively high importance is given to antifoulants in bottom paints. Less important issues include mining, dumping, radioactive waste, at-sea incineration, and most OCS development issues. Representatives of state and local governments are similar in their views to Federal executives. However, low priority is given to habitat issues and the importance given to nonpoint source pollution is not as high as might be expected.

The Legislative Branch respondents form a very small group, so the variance among their answers is quite high. Low importance is given to physical alteration, i.e. modification of wetlands and changes resulting from OCS on-shore activities. High priority issues include nonpoint source pollution, pipeline discharges, spills, and persistent marine debris.

Environmentalists who responded to the survey rate most issues higher than the sector mean. Especially high are OCS issues, radioactive waste, incineration, and offshore mining. Lower priority than in the sector mean is given to nutrients discharged from pipes. Participants involved in the fishing industry have views similar to those of environmentalists, except that they give fishing activities low significance as contributors to pollution. Nonpoint source pollution is rated low by fishermen; especially high importance is given to OCS chronic discharges, offshore dredged material disposal, offshore mining, and pipeline disposal of radioactive waste.

The ocean industry/minerals group, which includes both the oil and gas industry and marine mining interests, rates most issues low in significance. OCS activities are given a particularly low priority, while high importance is assigned deep seabed mining.

4. DISCUSSION

Highly Significant or Controversial Issues

The introduction of toxicants into the marine environment seems to be a common cause of concern about several of the highest priority issues. Activities which contribute to the problem include direct industrial discharges and indirect discharges via municipal treatment plants, and sewage sludge disposal by dumping or through pipelines. In addition, there is concern about the input of pesticides and metals from nonpoint source pollution, hazardous materials which are dumped or accidentally spilled at sea, and disposal of contaminated dredged material.

Loss and modification of coastal habitat is another general area of concern. This results from agricultural activities as well as coastal development and industry. Another highly significant issue related to development is the input of nutrients and pathogens. This results from nearshore disposal of municipal wastes and from nonpoint source pollution.

The opinion of the participants is divided on a number of issues (see Figure 4); the most noticeable differences concern radioactive waste disposal, atmospheric deposition, and at-sea incineration. Some of the differences are a result of the varying perspectives of the sectors, as discussed above.

Comments Made on the Worksheet

The comments made on the Worksheet show a broad range of opinions; nevertheless, some general statements about the comments can be made. Comments were made on the worksheet as a whole, on the criteria, and on the rated issues. Several additional criteria and pollution issues were suggested.

General comments on the Worksheet included statements that existing pollution controls are adequate, and that sometimes unnecessary regulations are promulgated for political rather than scientific reasons. On the other hand, some participants felt that because of lack of enforcement and widespread cheating, the regulations are ineffective. Some suggested that the biggest effect on the oceans comes from the fishing industry rather than the industries and activities which are traditionally thought of as polluters.

Several participants felt that the Worksheet demonstrates a problem with pollution research and regulation efforts in this country; instead of looking at each polluting activity separately, we should consider the entire system and the interrelationships between pollutant fate, ecological and economic effects, and government policy; we should then place management emphasis on multiple use of the oceans.

Several comments indicated confusion with parts of the Worksheet. For example, in Part I, the criteria may be ranked from 1 (highest significance) to 5 (lowest significance); while in Part II, the issues are ranked from 1 (lowest priority) to 5 (highest priority). The fifth criterion asked what weight should be given to whether the polluting activity was likely to increase or decrease in the next few years; this confused many people, who wrote "increase," "decrease," or "yes" instead of ranking it. It was pointed out that some of the criteria overlap or are interrelated; for example, the economic and social significance of the issues.

Many comments were made to the effect that the significance of the criteria and the importance of each polluting activity depend on the region and the specific site. It was noted that global issues are different from national ones, and concerns about deep water environments vary from those about lakes or near-shore areas. Many suggested that the Great Lakes be considered separately from the marine environment.

Comments on individual criteria generally explained why a criterion was or was not considered important. Several additional criteria were suggested. Many could be loosely defined as risk-analysis approaches; i.e. how do the risks of the polluting activity compare with the benefits, with the risks, costs, and effects of alternative disposal methods, and with the risks of other human activities? Other participants suggested consideration of the political significance of the problem, the significance to national security, the implications for international relations, or the impact on living marine resources and endangered species.

To judge the significance of a polluting activity, the magnitude of the problem and its long-term consequences must be known. Many people suggested as a criterion the question of "reversibility" and the amount of time and money required to reverse effects. Some considered whether more research is needed to solve the problem. It was pointed out that effects on ecosystems might be seen before human health effects, and that the maintenance of pristine environments should receive high priority. Some of the suggestions did not really represent criteria for judging the significance of the problems; rather, they were issues themselves, or were suggested solutions.

Comments were made on each polluting activity and each of the fourteen subdivisions. Some of these explained the ranking given, while others added new subactivities and pollutants.

Some participants pointed out that the input of nutrients from the disposal of sewage effluents and sludge does not cause eutrophication in all circumstances; there seemed to be more concern about toxic wastes from industrial discharges to treatment plants, including persistent organic compounds. Combined sewer overflows were suggested as an additional problem.

The significance of industrial waste disposal depends on the type and amount of waste, as well as the level and effectiveness of treatment and the disposal location. Toxic wastes are considered a particular problem for the Great Lakes. Some participants gave lower priority to regulated types of waste disposal; for example, they pointed out, ocean dumped waste must meet the ocean discharge criteria in Section 403 of the Clean Water Act and industrial pipeline discharges are regulated by EPA under NPDES. Some participants think that more research is needed on the effects of ocean incineration.

There was some disagreement about the significance of oil and gas development activities. There are technological advances and regulations that should eliminate the potentially serious problems of pipeline breaks and direct discharges of oil; companies that are responsible for accidental discharges are subject to penalties and lawsuits. Regulations, however, are not always adhered to, especially, it was suggested, by small nearshore operators.

The effect of onshore operations such as refining and storage facilities is considered to have a moderate to high significance locally, especially in the Gulf of Mexico. One example given was the effect on marshes. As with all polluting activities, the significance of oil and gas development and of accidental spills of oil and hazardous materials depends on the type of pollutant and the amount released.

Many participants felt that the significance of activities resulting in input of radioactive waste was difficult to assess, because of a lack of information about the effects and lack of experience with disposal methods. Currently, radioactive waste is not placed below the sea floor nor is it discharged through pipelines. One participant was of the opinion that sub-seabed emplacement is very promising, and is less risky than land disposal. The risks associated with radioactive waste disposal depend on the level of the waste, the location, and the technology used for transportation and disposal.

Some participants expressed the opinion that because of EPA permitting requirements, disposal of dredged material offshore is not a significant problem now; however, others noted that both near- and off-shore disposal can expose contaminated sediments. Contaminants can also be released through leaching and runoff from dredged material.

Marine transportation activities are considered especially significant in embayments. Pollution resulting from commercial (including research and shipping) and recreational vessel operations are in some cases controlled by regulations; one participant suggested the addition of pollution from recreational boat engines to the list of issues.

The loss of nets in fishing activities was called by one participant "a big self-inflicted source of competition." The input of commercial fishing bycatch may be decreasing as fewer species are discarded. A participant suggested that the disposal of bycatch may not have as serious an ecological effect as the killing of large numbers of unwanted fish in the first place. Bottom disturbance is considered a potentially very significant disruption of habitats; other detrimental effects on the environment from fishing activities, suggested by the participants, include depletion of resources by commercial and recreational overfishing, use of illegal fishing methods, and incidental take of fish and turtles by shrimp trawlers.

The effects of marine energy development are not seen as serious problems at the present time. In fact, one participant pointed out that the upward displacement of cold deep water from Ocean Thermal Energy Conversion (OTEC) could be a net benefit, unless it causes changes in the weather. OTEC's effects will depend on how close to shore or fishing areas the plant is operated. The participants noted that tidal power could have significant effects on wetlands and freshwater hydrology.

Marine mineral mining in the deep sea is regarded as a far-off prospect by some, and therefore not very significant. On the other hand, so little is known about some aspects of this activity that others rank it as highly significant. Manganese nodule mining will take place at great depths, so some participants felt that the disruption to the marine environment will be minimal; it was noted that the sediments there are not contaminated. It was

suggested that nearshore mining, especially of phosphate, would probably be more locally significant. The significance of dissolution mining from Strategic Petroleum Reserve operations will depend on the rates of activity and of dilution.

When considering problems of nonpoint source pollution, the participants generally rated them very highly; in the comments, many participants suggested additional pollutants not listed in the Worksheet, such as leached metals, toxic organic chemicals, petroleum products from road building, herbicides, chloride from road salt (in fresh water), and contamination of groundwater--and nearby estuaries--from hazardous waste dumps, landfills, and deep well injection. A participant opined that as new subdivisions are built near the water, problems with suburban runoff are increasing. A comment was made that mining runoff is more important inland than near the coast. Some participants felt that the importance of atmospheric deposition is uncertain, and one commented that it is especially important in large freshwater systems. "Acid rain" may cause mobilization of metals in freshwater estuaries and marshes, it was noted.

Physical alterations of critical habitats also are considered important. A participant noted that agricultural activities are generally more significant inland than at the coast, although water diversion upstream affects estuaries and bays in some areas. It was suggested that harbor development be added to the list of development activities in the Worksheet. Other activities leading to habitat modification are alteration of salinity regimes and freshwater inflows, wetland loss due to subsidence, and historical deposition of toxic residuals which get into the food chain. Some participants pointed out that mitigation is not always done, and that when it is, there is a lack of proven techniques, regulation, and monitoring to document successes or failures.

Several new issues were raised by the Worksheet participants. Many of these are not pollution problems in the traditional sense of input of contaminants, but are changes in the environment which may have detrimental effects on ecological health. These include sea level rise, mariculture, the effect of harvesting on populations, subsistence hunting in Alaska, and bottom disturbance by bottom fisheries. There may be a net increase in pollution due to transportation of offshore-produced pollutants to coastal and onshore areas for disposal. Other participants mentioned military uses of the ocean or solid waste disposal, novel pollutants, and translocation of organisms containing pathogens. In addition, it was suggested that we are just now beginning to understand the effects of persistence and bioavailability of toxic substances and the synergisms between toxic organics, nutrient enrichment, coastal pathogens, and physical change.

5. CONCLUSIONS

The perception in the ocean community regarding importance of pollution issues has not changed much in the last three years. The most important issues relate to the introduction of toxic chemicals, nutrients, and pathogens into the marine environment. Polluting activities of greatest concern are the disposal of municipal waste and industrial waste, activities which cause loss and modification of habitat, and sources of nonpoint source pollution. The least serious pollution problems include those resulting from marine energy development, deep seabed mining, and most terrestrial mining activities.

Controversial issues, those on which the participants are divided, include radioactive waste disposal, at-sea incineration, and OCS development. From the results of the National Marine Pollution Priorities Worksheet, it appears that issues relating to modification and loss of critical marine habitats may have increased in priority.

The most important criterion for determining the significance of a polluting activity is its effect on human health; a close second is the effect on ecosystem health. The participants seemed to be divided about the activities which are not currently being performed and those which are regulated. On the one hand, there are those who see these issues as less significant. However, others feel that the enforcement of regulations is inadequate or that those issues which are currently of low priority may become important in the future. From the point of view of the need for research, activities such as at-sea incineration and radioactive waste disposal may be considered important because they are controversial; people have disparate perceptions of their priority.

Analyzing the results by sectors of the marine community demonstrates that the opinions of these various groups differ on some issues, as would be expected. In general, participants from state and local governments and scientists employed in the Federal Government rated most issues close to the mean for that issue. Environmentalists and fishing industry representatives rated most problems more highly significant, while Federal Executive Branch managers and those involved in the production of oil and gas or marine minerals think that most issues are less significant than the whole group. Scientists in academia and Congressional staffers give some issues much higher and others much lower priority than the mean.

Based on the results of the Worksheet, The National Marine Pollution Problems and Needs Workshop for 1987 was organized in four working groups to address the Federal effort in the four highest priority areas: habitat loss and modification, pipeline disposal of industrial waste, pipeline disposal of municipal waste, and nonpoint source pollution. The results of the priorities study also contributed to the "Ocean Pollution Policy Board Program Planning Paper," which was developed by the staff of NMPPPO to assist the Federal agencies participating in the National Marine Pollution Program in focusing their efforts on the highest priority problems.

The identification and prioritization of marine pollution issues and the corresponding research needs is only the first step in the planning process for the National Marine Pollution Program. Each year, NOPPO updates the Summary of Federal Programs and Projects, which gives information about the Federal program in marine pollution research, development, and monitoring. The results of the National Marine Pollution Priorities Worksheet and the 1987 Workshop on National Marine Pollution Problems and Needs will be used in preparing the Federal Plan for National Marine Pollution Research, Development, and Monitoring, FY 1988-1992. The Plan will focus on the goals of the National Marine Pollution Program in understanding the sources and effects of toxic substances, nutrients, and pathogens in the marine environment, the causes and effects of critical habitat loss, and the effects of marine pollution on human health and ecosystem integrity.

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