

**Report on a Workshop on Fisheries-Generated
Marine Debris and Derelict Fishing Gear**

OCEANS OF PLASTIC

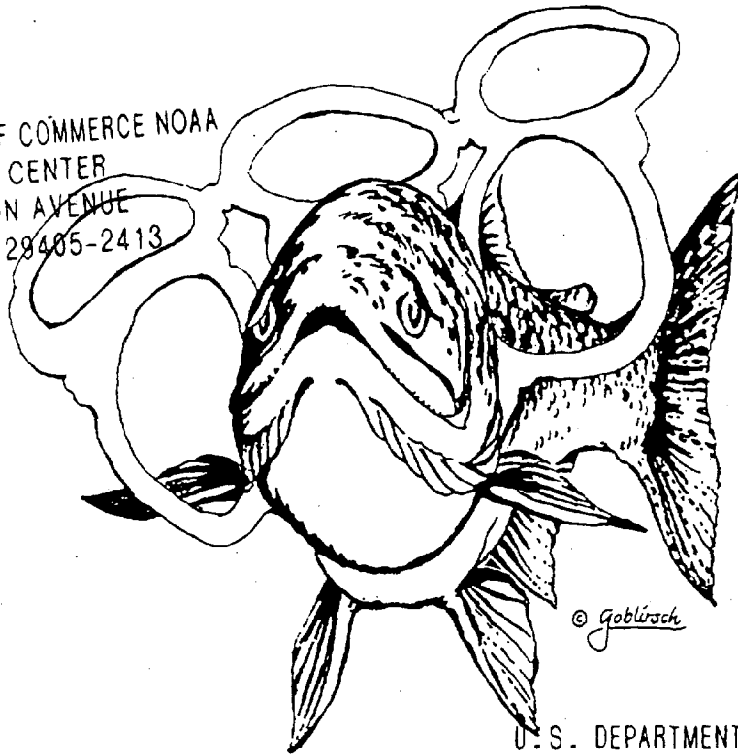
**February 9-11, 1988
Portland, Oregon USA**

**ALASKA SEA GRANT REPORT NO. 88-7
UNIVERSITY OF ALASKA
DECEMBER 1988**

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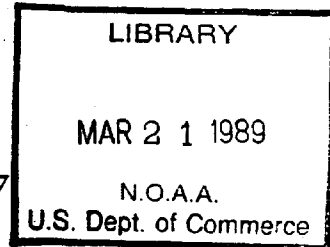
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ALASKA SEA GRANT COLLEGE PROGRAM
138 IRVING II
UNIVERSITY OF ALASKA
FAIRBANKS, AK 99775-5040



AUG 27 1987

558-2-133-88-7
R1333631

Elmer E. Rasmuson Library Cataloging-in-Publication Data

Workshop on Fisheries-Generated Marine Debris and
Derelict Fishing Gear (1988 : Portland, Or.)
Oceans of plastic : report on a Workshop on
Fisheries-Generated Marine Debris and Derelict Fishing
Gear, February 9-11, 1988, Portland, Oregon, USA.

(Alaska sea grant report ; no. 88-7)

1. Marine pollution--Environmental aspects--Congresses.
2. Fisheries--Equipment and supplies--Environmental aspects--
Congresses. I. Alaska Sea Grant College Program. II. Title.
- III. Series: Alaska sea grant report ; 88-7.

GC1081.W67 1988

ACKNOWLEDGEMENTS

Funding for the Oceans of Plastic workshop was provided by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration. The workshop was sponsored by the Alaska Sea Grant College Program with assistance from the nationwide Sea Grant network and Sea Grant programs at the following universities:

University of Washington
Oregon State University
University of Hawaii
University of California
Louisiana State University
University of Georgia
University of Maine

This booklet was produced by the Alaska Sea Grant College Program which is cooperatively supported by the U.S. Department of Commerce, NOAA Office of Sea Grant and Extramural Programs, under grant number NA86AA-D-SG041, project number A/75-01; and by the University of Alaska with funds appropriated by the state.

We are grateful to Martha Eliassen for helping to write this report. The cover art is by Herb Goblirsch, and the cover design by Karen Stomberg.

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I. INTRODUCTION

Fishermen, marine researchers, educators, plastics manufacturers and government representatives--more than 80 in all--met in Portland, Oregon February 9-11, 1988, for "Oceans of Plastic," a workshop to address problems caused by fisheries-generated plastic debris and derelict fishing gear. The workshop examined ways to reduce marine plastic debris and explained new laws intended to halt plastic pollution in the ocean.

Discussion during the three days indicated that many commercial fishermen, faced with a threat to waters that generate their livelihood, have assumed leadership in fighting marine plastic debris and believe that their industry does not at this time need special government regulation. Fishing industry representatives said the best incentive for fishermen to reduce their contribution to the plastic debris problem is education, coupled with assistance in shoreside solid waste disposal. Although some workshop participants expressed doubts about whether education alone can rectify the problem, most agreed educational efforts will help reduce marine plastic debris.

Plastics in the ocean cause serious problems, but they represent only a portion of the solid waste dilemma nationwide. Annex V of the International Convention to Prevent Pollution from Ships (called MARPOL), which takes effect December 31, 1988, prohibits dumping plastics into the ocean. Some waste plastic will be burned at sea, but the rest will come ashore. In many coastal communities, particularly those in which landfill space is limited, the new law will be a burden.

The Portland workshop, sponsored by the National Oceanic and Atmospheric Administration and conducted by Sea Grant, was planned to accomplish the following objectives:

- A. Contribute to the understanding of fisheries-generated marine plastic debris.
- B. Investigate ways to reduce the amount of fisheries-generated marine debris.
- C. Identify effective ways--including possible incentives--to reduce derelict fishing gear.
- D. Contribute to the nation's marine debris education program.

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Frank discussion on a broad range of topics resulted in general and in most cases unanimous agreement on many points. These points were condensed in an open session at the end of the workshop, during which participants agreed upon specific language to carry their ideas to Washington, D.C. This language, which provides the framework for this report, appears in bold print throughout the document.

II. THE MARINE PLASTIC POLLUTION ISSUE--BACKGROUND

Persistent plastics in the ocean have aroused concern of fishermen, mariners, biologists, beach-goers and others who have contact with the marine environment. Problems caused by this synthetic jetsam range from the aesthetic, when tons of scrap plastic pile on a well-loved beach, to the life-threatening, when propellers foul in derelict fishing gear. Waste plastic threatens marine life, too; fish, birds and mammals ingest it or become entangled in it, although little quantitative data exists with which to assess the magnitude of this problem.

Isolated efforts to combat marine plastic pollution--including those by individual fishermen, fishermen's associations and beach groups--have been ongoing for a number of years. But those familiar with the debris problem felt a more comprehensive approach was needed. In April 1987 the issue became focused in Washington, D.C. after 30 U.S. senators signed a letter to the President. The letter outlined the impact of plastic waste on marine resources, formally sounding the alarm against a formidable environmental hazard.

The President forwarded the letter to the Domestic Policy Council, which in turn called upon federal agencies, under the leadership of NOAA, to cooperate to combat marine debris with efforts such as this workshop. At the same time, national legislators initiated a number of bills aimed at reducing the marine plastic pollution. Two of those bills became law at the end of 1987.

After ratifying Annex V of the International Convention to Prevent Pollution from Ships (MARPOL), Congress passed Public Law 100-220, which contains two relevant acts: the Plastic Pollution Research and Control Act and the Drift Net Impact, Monitoring and Control Act.

The first piece of legislation addresses the general plastic debris problem. It implements MARPOL, the international convention that prohibits all ocean discharge of plastics, and charges the U.S. Coast Guard with writing appropriate regulations. Further, the act charges the Environmental Protection Agency and the National Oceanic and Atmospheric Administration with tasks aimed at reducing marine plastic waste.

The Coast Guard is further charged with reporting on the level of compliance with the new law one year after it becomes effective and biannually thereafter for a period of six years.

The drift net law is narrower in scope. It addresses the portion of the high seas gill net fishery of the North Pacific, primarily foreign-based, that employs nets more than 1.5 miles long. Among its other provisions, the law requires a feasibility study of a net bounty system, which would encourage retrieval of lost gill nets, and a study of a net marking system, which would allow the U.S. government to readily identify high sea gill net gear. (For more background, see workshop chairman Robert Schoning's opening remarks in the appendix to this report.)

III. MARINE PLASTIC POLLUTION--THE FISHING INDUSTRY'S ROLE

"THE DOMESTIC COMMERCIAL AND RECREATIONAL FISHERIES CONTRIBUTE DEBRIS TO THE OCEAN IN VARIOUS WAYS, BUT THEY CLEARLY ARE NOT THE MAJOR CONTRIBUTORS."

According to data compiled from beach surveys around the country, marine debris comes from a variety of sources: inadequate municipal treatment systems, beach users, the oil and gas industry, recreational boating, commercial fishing and cargo vessel traffic of all types. Types of beach debris vary among geographical regions. The only area where derelict plastic fishing gear comprises the predominant beach debris is the northern North Pacific, where there are few coastal towns and plenty of fishing boats.

Regardless of the source, the problem is substantial. In 1987, 26,500 volunteers gathered 700 tons of trash from 1,800 miles of U.S. coastline in 19 of 21 marine

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coastal states. These annual beach clean ups, hosted on a state-by-state basis, typically last only one day.

Contents of sample bags were segregated by type and counted; these data were combined with information from inventory cards completed by clean up volunteers. Researchers extrapolated the following statistics from the data: Nationwide, between 40 and 60 percent of beach debris is plastic. Another 10 to 20 percent is expanded polystyrene foam. In other words, between 50 and 80 percent of materials washing ashore don't degrade in the environment.

Plastic debris specific to the fishing industry ranges from galley waste--including food wrappings and packaging--to web scraps cut during mending and thrown overboard. Derelict fishing gear--nets, trawls, pots, lines--is lost in bad weather or in accidents. Because of the expense and potential hazard, fishermen are generally careful to prevent gear loss. Exceptions noted included gear willfully abandoned by foreign vessels discovered in closed areas, and domestic gear left on fishing grounds during brief, intense season openings in which recovery of set gear would violate regulations or waste valuable fishing time.

"MEANINGFUL EFFORTS ARE ONGOING IN REDUCING DERELICT GEAR IN MANY FISHERIES AROUND THE COUNTRY."

Industry representatives noted that each fishery uses specialized gear, and anecdotal evidence indicates that different gear types present different problems if lost or abandoned. For instance, lost gill nets are reported to collapse and ball up under their weight and through motion of ocean currents within a matter of weeks. Lost shrimp and crab pots without degradable escape panels, however, are said to continue to "ghost fish" for some time, perhaps years.

Harvest policies influence the derelict gear problem. Several examples were cited. In Puget Sound, a gill net fishery runs at the same time as a Dungeness crab fishery, leading to pot loss through entanglement. In brief season openings, which are familiar in Alaska waters, fishermen may set more gear than they can retrieve before closing.

Discussion highlighted differences in opinion--and the lack of solid, scientific information--about the magnitude of effects of derelict gear on marine ecosystems. It is clear that birds and mammals become entangled and die. It is clear that derelict fishing gear continues to fish to some degree. What is the long-term impact on resources? Nobody knows for sure.

It also became obvious during discussion that the plastic debris pollution issue and foreign high seas gill net fisheries issue have become confused, possibly because P.L. 100-220 addresses both. Because U.S. fishermen use a great variety of gear, including gill nets, problems caused by plastic debris, derelict fishing gear and mammal entrapment in active gear should be separated.

"PROBLEMS RELATED TO REDUCTION OF FISHING INDUSTRY DEBRIS IN THE OCEAN MAY VARY SIGNIFICANTLY AMONG DIFFERENT GEOGRAPHICAL AREAS AND FISHERIES AND SHOULD BE CONSIDERED ACCORDINGLY."

"THE NORTH PACIFIC FISHING INDUSTRY HAS DEMONSTRATED LEADERSHIP IN FINANCING ACTIVITIES TOWARD REDUCING ITS CONTRIBUTIONS OF PLASTIC TO THE OCEAN, RECOVERING AND RETURNING PLASTIC TO SHORE, PROPER DISPOSAL OF PLASTIC AND DEVELOPMENT OF NEEDED PERTINENT KNOWLEDGE."

The fishing industry tackled the marine debris issue before Congress passed recent laws. In the North Pacific, domestic and foreign-based fishermen have spent their own funds for educational materials. In October, these fishermen sponsored an international conference in Kailua, Hawaii, to examine and share information about plastic debris pollution and to recommend and adopt steps to reduce fisheries-generated marine debris and derelict gear.

"THERE ARE STRONG INDICATIONS THAT SEGMENTS OF THE FISHING INDUSTRY WILL CONTINUE TO PROVIDE LEADERSHIP AND SUPPORT IN ADDRESSING OCEAN DEBRIS PROBLEMS, PARTICULARLY THOSE RELATED TO INDUSTRY ACTIVITIES."

During a roundtable discussion, fishing representatives said they support the idea of taking a leadership role to deal with the marine plastic debris issue. Some fishermen, such as those in the North Pacific, should continue leadership they've already

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assumed; fishermen in other areas agreed they should unite and face the issue head-on to demonstrate that government regulation isn't necessary.

There were, however, some reservations expressed. Some industry representatives noted that they are leading the fight against marine debris and it has placed them in a high-profile position, making the fishing industry a potential political target. Assumption of leadership can be misconstrued as an assumption of responsibility for the entire marine debris problem. Industry representatives expressed the importance and advantages of taking leadership, but said they preferred leading a broad-based effort among all groups that use the ocean.

IV. MARINE PLASTIC POLLUTION--SOLUTIONS

The bulk of the workshop time was spent discussing potential solutions--ranging from government-initiated financial incentive programs to education and technology--to the marine plastic pollution problem. Following are summaries of these discussions.

A. Financial Incentive Systems

This workshop session began with panel presentations. Xan Augerot of Washington Sea Grant explained various types of financial incentive systems for consideration. These systems were evaluated by Jon Sutinen, a resource economist with the University of Rhode Island. Casey Jarman of the University of Hawaii Richardson Law School addressed legal structures affecting enactments of those systems. Background papers written by these individuals are included in the appendix to this report. Following panel presentations, industry representatives responded.

"A VARIETY OF ECONOMIC INCENTIVE-TYPE PROGRAMS FOR REDUCING GEAR DISCARD AND LOSS AND ENCOURAGING SUBSEQUENT RECOVERY WERE DISCUSSED AT LENGTH, BUT SIGNIFICANT SHORTCOMINGS WERE EVIDENT WITH EACH, BASED ON PRESENT UNDERSTANDING AND DIFFERENCES IN THE CONDUCT OF SPECIFIC FISHERIES. BECAUSE DOMESTIC COMMERCIAL FISHERIES VARY GREATLY IN TYPE, COST, EXTENT AND FREQUENCY OF GEAR LOSS, OPERATION METHOD AND AREA AND AMOUNT OF LOGISTICAL SUPPORT REQUIRED, C. Educational Incentives

"THE SINGLE MOST WIDELY SUPPORTED APPROACH TO ADDRESSING THE PROBLEM OF REDUCING FISHING INDUSTRY PERSISTENT DEBRIS WAS EDUCATION OF ALL SEGMENTS OF THE PUBLIC AND USER GROUPS, AND SUPPORT AND ENCOURAGEMENT OF PRODUCTIVE ONGOING EFFORTS, BASED ON MEASURABLE SUCCESS ALREADY OBTAINED THROUGH SUCH ACTIONS. A CLEARINGHOUSE FOR INFORMATION NATIONALLY AND INTERNATIONALLY IS ENCOURAGED."

During discussion of financial incentive and bounty systems, a semantical gap between the fishing industry and government administrators became apparent. Fishermen interpret the word "incentive" broadly, as does *Webster's New World Dictionary*: "... something that stimulates one to take action, work harder, etc."

Instead of a new government program, fishing industry representatives recommend education and information as incentives for fishermen to help reduce marine plastic debris. As one Northeast fishery leader said, "I'm of a mind that if we have any funds ... rather than impose sheaves of regulations that are going to be unenforceable, impractical, let's put our funds in education."

Other regional fisheries representatives reinforced the idea that education is the best answer to marine plastic pollution at this time. As one speaker noted, "The worst way to get a fisherman to do anything is to tell him he's got to do it."

During the evaluation of approaches to abating marine plastic debris it was noted that educational programs are popular because they are politically attractive, don't cost much and meet other favorable criteria including lack of interference with individual decision-making. However, it was also noted that education and publicity efforts often have only modest effectiveness and lack permanence.

Other workshop speakers had more favorable views of educational programs. The year-old Marine Refuse Disposal Project in Newport, Oregon, is an example of a successful education and information campaign. This pilot project was funded by the National Marine Fisheries Service Marine Entanglement Program in anticipation of passage of the MARPOL Annex V legislation. The project is in two interrelated parts:

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ANY REGULATORY APPROACH GOVERNING DISPOSAL AND RECOVERY OF FISHING EQUIPMENT WARRANTS FURTHER STUDY."

1. Pollution rights

This type of incentive system, in which a user buys a permit to pollute at a certain level, isn't applicable to the marine debris issue because the Plastic Pollution Research and Control Act prohibits dumping plastics into the ocean.

2. Net deposit

A net deposit system, as presented at the workshop, would be patterned after bottle bill legislation. Fishermen would pay a deposit on gear at the time of purchase. A refund would be made to anyone who returned the gear to a refund location.

"INCENTIVE-TYPE APPROACHES REQUIRING ADVANCE DEPOSITS WHEN PURCHASING GEAR AND PROVIDING REFUNDS UPON RETURN WERE OPPOSED BECAUSE OF DIFFICULT BOOKKEEPING INVOLVED AND BECAUSE OF THE EXTENDED PERIODS OF TIME DEPOSITS WOULD BE OUT-OF-POCKET, PRESUMABLY IN A GOVERNMENT ACCOUNT."

3. Inventory

In an inventory system, all gear purchased and taken aboard a vessel would be recorded. If a fisherman didn't return gear to a refund location within a specified time, he or she would pay a "deposit." If the gear was eventually returned, the deposit would be divided among the gear retriever, the shoreside disposal agent and, if the gear was marked, the original owner. The inventory system required, however, might be too burdensome to be feasible.

"THE SIGNIFICANTLY EXPANDED BUREAUCRACY AND ASSOCIATED GOVERNMENT RECORDKEEPING ARE MAJOR DETERRENTS TO SOME FINANCIAL INCENTIVE CONCEPTS."

Jon Sutinen evaluated financial incentive systems on the basis of eight criteria: effectiveness, permanence, behavior modification, cost effectiveness, fairness, degree of interference with individual decision-making, political effectiveness and enforcement considerations. Nearly all of the financial incentive systems, particularly the deposit system, received high marks from Sutinen when judged on these points (see Appendix D discussion paper).

The proposed system did not, however, receive high marks from fishermen. Fishing industry representatives objected to any regulatory program that would add to the cost of operation or levy fines for inadvertent gear loss. They also objected to the idea of a new bureaucracy created to oversee a new regulatory system--a system that would keep track of deposits on gear and/or gear identification for an estimated 130,000 commercial fishing vessels.

B. Bounty System

Under a bounty system, fishermen would receive financial reward for bringing ashore their old gear and any gear they find. Such a system could be funded from the federal treasury or other sources. The recently passed Drift Net Act requires a feasibility study of bounties for possible application to the high seas drift net fishery.

"THERE ARE POTENTIALLY POSITIVE SUCCESSFUL APPROACHES TO ENCOURAGING RECOVERY OF DERELICT FISHING GEAR AND RETURNING IT TO PORT WITHOUT INVOKING PENALTIES FOR INADVERTENT LOSSES. THE INDUSTRY SUPPORTS THE CONCEPT OF AT LEAST REIMBURSING AN INDIVIDUAL FOR COSTS INCURRED IN COLLECTING AND RETURNING DERELICT GEAR AND POSSIBLY PROVIDING A SMALL REWARD FOR SUCH ACTION, BUT FURTHER REFINEMENT OF THIS CONCEPT IS NECESSARY."

"THERE IS NO ENDORSEMENT OF ANY BOUNTY OR FINANCIAL INCENTIVE-TYPE APPROACH AT THIS TIME BECAUSE OF THE VARIETY OF SIGNIFICANT AND REAL PROBLEMS FACING EACH, BASED ON AVAILABLE KNOWLEDGE OF THE APPROACHES AND THE FISHERIES. FURTHER, SUCH MAJOR CHANGES IN ADDRESSING THE OCEAN DEBRIS PROBLEM, BY SELECTING ONE OF THE LESSER CULPRITS, WITHOUT THE SUPPORT OF INDUSTRY, WOULD BE DEVASTATING TO CURRENT OR FUTURE COOPERATION AND EFFECTIVENESS."

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C. Educational Incentives

1. making sure port facilities are adequate to handle plastics that port users return, and
2. making mariners aware of the serious nature and effects of plastic debris and encouraging action.

The majority of Newport fishermen now voluntarily dispose of their plastic trash in port. Trash bins near the docks make this easy. The project's director said program success stems from motivations that education and awareness foster. Fishermen have not only become involved in overcoming the marine debris problem, they feel ownership in this task and in their accomplishments.

Newport fishermen participate in a variety of activities that help generate this feeling of ownership. They appear in television ads, lead groups of kids on bay clean up activities and wear sweat shirts and hats with the "Don't teach your trash to swim" logo. Most importantly, they talk to their peers on marine radio, in bars and restaurants on the docks.

One trawler was overheard saying to another as their boats drew together to transfer a crew member, "Is that YOUR garbage in the water? We don't do that anymore here."

Part of the project's success may be attributed to its approach.

"If you want this marine debris problem to be solved, you have to offer the fishermen something," the project director said. "Something simple and inexpensive (such as coffee and donuts on the docks) but sincere and welcome. Then ask for their help."

Although the pilot project is nearly over, the program was designed to be self-perpetuating. Garbage bins are on the docks, fishermen are aware.

"THE RECENTLY COMPLETED NEWPORT, OREGON, MARINE REFUSE DISPOSAL PROJECT WAS DEEMED HIGHLY SUCCESSFUL, WITH POTENTIAL FOR ADOPTION BY OTHER DOMESTIC PORTS. DISTRIBUTION OF WRITTEN HIGHLIGHTS OF THE PROJECT TO OTHER DOMESTIC PORTS IS ENCOURAGED."

"THE SUPPORT AND INVOLVEMENT OF THE FISHING INDUSTRY IN REDUCING MARINE DEBRIS PROBLEMS CAN BEST BE ENCOURAGED AND OBTAINED BY POSITIVE APPROACHES RATHER THAN BY THREATS OF INCREASED OPERATIONAL COSTS AND PUNITIVE ACTIONS ASSOCIATED WITH SOME FINANCIAL INCENTIVE PROGRAMS."

D. Technology

In addition to the array of incentives discussed, technology also will play a role in reducing plastics in the ocean. Options include: using degradable plastic for packaging as well as fishing gear; recycling plastics; and marking nets at the time of manufacture to identify owners at some point in the future.

1. Degradable and recyclable plastic

"THERE IS ONGOING AND PROPOSED RESEARCH ON MODIFYING PLASTIC MATERIAL TO MAKE IT MORE ADAPTABLE TO DISPOSAL AND RECOVERY."

Plastics industry representatives said research has led to development of some degradable plastics. They also indicated that most plastics are recyclable. Research to further develop and refine both technologies continues. Although some degradable plastic packaging products are on the market and some recycling is conducted, this is an area for growth.

"EFFORTS TO IMPROVE BIODEGRADABILITY OR DISPOSABILITY OF FISHING GEAR SHOULD AVOID MAKING MATERIALS MORE COSTLY, OR LESS SAFE, EFFICIENT OR SERVICEABLE."

Although few question the wisdom of degradable six-pack yokes, fishing gear designed to break down in the environment is another matter. Degradable escape panels of natural materials have been available for crab, shrimp and lobster pots for some time, but degradable synthetic nets haven't been developed yet and probably won't be for a number of years. Still, interest in such a product remains strong. The Stevens Institute of Technology's Polymer Processing Institute recently received a \$187,000 Saltonstall-Kennedy grant to develop materials for fishing traps and pots that will degrade in sea water.

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Fishermen are concerned about the concept of netting that disintegrates. They say such materials may make on-board operations unsafe and are likely to significantly increase the cost of gear. About half-way through the workshop, one Northwest fisheries leader expressed uneasiness about what he'd heard so far. "Can you imagine what would happen to me if I went back and told my fishermen that they were going to have to pay a 10 percent surcharge for (gear) identification and then they were going to have to pay a deposit on a net that's going to biodegrade in two years?"

A fishing gear manufacturer said biodegradable synthetic netting or line would be acceptable only if

- a. new materials are as strong as those now used.
- b. it's affordable.
- c. it biodegrades only if lost.

A plastics researcher said that although there are ways to make plastics degradable, little is known about behavior of plastic in the ocean environment. Researchers must know more about the material to determine when and how it will degrade, and that information must be passed to fishermen, before biodegradable or photodegradable nets and lines are a viable option.

"THE PLASTICS INDUSTRY IS COOPERATING IN ADDRESSING SPECIFIC NEEDS OF THE FISHING INDUSTRY IN USING AND DISPOSING OF PLASTIC MATERIALS, BUT MORE WORK NEEDS TO BE DONE."

2. Net-marking

The concept of marking nets for registration and identification purposes arose in the early 1980s in response to concerns about gear abandoned in the high-seas drift net fishery. Northwest Marine Technology has a grant from the NMFS to develop a method to mark nets during manufacture. A researcher for that company said he's confident the technology is available, but the question is one of politics. Is net-marking desirable? The fishing industry says not on an individual vessel owner basis. Fishermen are worried about liability for problems caused by long-lost gear. Marking on a country-by-country basis may be acceptable.

"SERIOUS CONCERNS WERE EXPRESSED ABOUT THE CONCEPT OF REQUIRING NETTING TO BE INDIVIDUALLY MARKED AT PURCHASE SO IT CAN BE TRACKED THROUGHOUT ITS LIFE AND SO A REFUND MAY BE PAID TO ANYONE WHO RETURNS IT. THERE IS MUCH TRADING, LOANING AND SELLING OF PIECES OF WEB-BING AND THE SUBSEQUENT POTENTIAL LIABILITY FOR DAMAGE OR HARM TO WILDLIFE OR HUMANS AFTER INADVERTENT LOSS IS FRIGHTENING. FURTHER, LOGISTICAL AND ADMINISTRATIVE PROBLEMS AND POTENTIAL FOR ABUSE WOULD BE MASSIVE."

"THE DOMESTIC FISHING INDUSTRY SHOULD NOT BE SUBJECTED TO PROGRAMS RELATING TO MARKING OR IDENTIFYING GEAR TO ADDRESS A PROBLEM CAUSED BY FOREIGN FISHING VESSELS."

"THE CONCEPT OF MARKING FISHING EQUIPMENT DURING MANUFACTURE FOR FUTURE IDENTIFICATION OF PARTS OR THE WHOLE WARRANTS CAREFUL EVALUATION."

V. MARINE PLASTIC POLLUTION--EDUCATIONAL NEEDS

"A VARIETY OF BROADLY BASED EDUCATION PROGRAMS HAVE RESULTED IN INCREASING AWARENESS AND CONCERN, WITH POSITIVE, RELATED ACTIONS AND INVOLVEMENT BY A BROAD SEGMENT OF THE PUBLIC NATIONWIDE. IT IS RECOGNIZED THAT SUCH PROGRAMS ARE COST-EFFECTIVE AND SHOULD BE CONSIDERED BY PRODUCERS AND USERS AS WELL AS GOVERNMENT."

If there was one point upon which all workshop participants agreed, it was that more education about the marine plastic debris issue is needed. Different user groups need different types of education.

In addition to information about the Newport refuse project, and the consequences of plastic pollution, individual fishermen need accessible, pertinent information about the Plastic Research and Control Act before it take effect on December 31, 1988. Other members of the fishing community, such as fish processors and fishing port administrators, will be affected by the new law, too, and also need information.

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As new technology becomes available to cope with or prevent marine plastic problems, a mechanism for delivering that information in a timely manner should be established. At the workshop, the idea of a national clearinghouse was endorsed. The clearinghouse might consist of a well-defined network of all of the entities involved: Sea Grant, National Marine Fisheries Service, the U.S. Coast Guard, the Environmental Protection Agency, state and local governments, port authorities, fishermen's associations, environmental groups and others.

Representatives of various government agencies expressed the desire that educational programs be spearheaded by fishermen and other user groups. Sea Grant and other agencies should provide support but should not take leadership away from the fishing industry or others who already are addressing this issue.

Since the fishing industry isn't the only group with a stake in clean oceans, other user groups need access to information and to this national clearinghouse. Workshop participants suggested sharing information about beach surveys and beach clean ups nationwide, to make efforts and resulting data more homogenous.

"BEACH CLEAN UP PROGRAMS SUCH AS 'ADOPT-A-BEACH' AND 'GET THE DRIFT AND BAG IT' HAVE GENERATED GREAT NATIONAL PUBLIC INTEREST AND INVOLVEMENT IN COLLECTING DEBRIS IN MARINE AREAS AND THE CONCEPT AND PARTICIPATION ARE RAPIDLY EXPANDING."

VI. MARINE PLASTIC POLLUTION AND THE SOLID WASTE DILEMMA

"SHORESIDE WASTE DISPOSAL OF MARINE DEBRIS IS ONE OF THE MOST PRESSING AND PERPLEXING PROBLEMS FACING THE FISHING INDUSTRY IN IMPORTANT REMOTE FISHING COMMUNITIES."

In each workshop session, discussion returned time and again to an obstacle that exacerbates the marine plastic debris problem and is bound to interfere with smooth implementation of the Plastic Pollution Research and Control Act: lack of adequate solid waste disposal facilities ashore.

At the end of this year, when boats are required to bring ashore all plastic garbage, the effects on coastal communities will be profound. Consider the case of Dutch Harbor, the port for the town of Unalaska, Alaska. A tiny fishing village of 1,800 tucked into the rocky, Aleutian landscape, Dutch Harbor serves 800 Bering Sea fishing boats--foreign and domestic--with more than 4,000 port calls each year. The town's landfill will be full in two years, and a new site hasn't been identified. In Unalaska as well as many other small ports, the shift of the solid waste burden from the fleet, often home-ported elsewhere, to the municipality, will be substantial.

Even communities whose landfills aren't nearing capacity may be pressed to accommodate trash brought ashore by merchant vessels, cruise ships, military ships and fishing boats. Some larger vessels are like floating cities, each day generating hundreds of bags of trash that are now dumped overboard. A specific example mentioned during discussion was a military vessel reported to produce 500 bags of trash per day. In some ports, especially in small, remote towns, the cost of dumping trash is prohibitive, providing a blatant disincentive for compliance with the new law. Furthermore, it would discourage fishermen from bringing ashore debris left by others and picked up in nets. City government in one Alaska coastal community reportedly considered raising landfill fees to \$200 per ton.

Solutions to this waste disposal problem are too involved to address in the context of marine plastic debris; the entire nation must at some point find creative ways to deal with all the trash--particularly non-degradable types--produced by a consumptive society. In the short-term, however, there are some steps that could help fishermen comply with the new law, such as improved, safer technology for onboard incineration of plastics and other trash, expanded plastics recycling, a switch to alternative packaging materials such as paper, and financial assistance to help ports deal with ramifications of MARPOL Annex V.

Finally, widespread distribution of the plan initiated by the Port of Newport in the pilot project mentioned earlier in this report may help coastal towns prepare for the coming flood of marine-generated plastic waste.

"CONSIDERABLY MORE INFORMATION IS NEEDED CONCERNING THE RELATIVE MERITS OF PRESENTLY KNOWN APPROACHES TO INCINERATION AT SEA, RECY-

CLING OF MATERIAL BROUGHT ASHORE AND SHORESIDE DISPOSAL OPTIONS. MUCH PROGRESS, HOWEVER, HAS BEEN MADE ON THE LATTER TWO."

VII. SUMMARY

Although some people believe fishermen need financial inducement to comply with the Plastic Pollution Research and Control Act, fishing industry representatives who attended the conference made convincing arguments against instituting a new regulatory program targeting fishermen. Some segments of the industry have initiated their own programs to clean up the ocean, and other fishermen have indicated interest in following suit. Efforts to mitigate marine debris should for the present be aimed toward educational programs, for fishermen and all who use the ocean. If compliance reports called for by the new law indicate educational efforts are inadequate, regulatory programs should be pursued only with the involvement of the industry.

VIII. RECOMMENDATIONS

- A. Distribute nationally summaries of the highly successful Newport Marine Refuse Disposal Project for application and use, and support funding of similar projects in other selected ports.
- B. Develop a national repository and clearinghouse for collection and dissemination of information on the marine debris problem.
- C. Maximize development of voluntary approaches to attack the marine debris problem through involvement of the domestic commercial and recreational fishing communities and general public through expansion of current successful programs. If voluntary approaches prove inadequate in reducing fisheries-generated marine debris and derelict fishing gear, explore with fishing industry leaders the possible development of incentive programs to minimize release of fishing gear and to maximize recovery and appropriate disposal of such gear.

- D. Encourage the plastics industry to work more aggressively and directly with the fishing industry to address general as well as specific plastic-oriented problems associated with individual fisheries.
- E. Explore practical ways to dispose of plastic debris and derelict fishing gear ashore, particularly in isolated fishing communities such as those in Alaska. Explore technologies such as onboard incineration and recycling to reduce the impact of fisheries-generated debris on shore-based disposal facilities. Encourage use of alternative packaging materials, such as paper, aboard vessels.

APPENDICES

Appendix A is the opening remarks of Robert Schoning, workshop chairman. Appendices B, C, and D were documents submitted to the workshop to provide background and stimulate discussion on the marine debris issue. The documents do not necessarily reflect conclusions or recommendations of the workshop.

APPENDIX A

**Nature of the Marine Plastic Debris Issue
Opening Remarks**

February 9, 1988

Robert Schoning, Oceans of Plastic Workshop Chairman

Why should anyone be concerned about plastic debris in the ocean? The ocean is very large and very deep and we could never fill it with anything, let alone plastics. Besides, we have to do something with all the plastics we make and use every day. The ocean is a readily available disposal site, particularly for boat operators to use, and the price seems to be right. Or is it?

Dave Cottingham has told us that most of the nations of the world are very concerned about the matter and have ratified a document which prohibits the deliberate release into the ocean of a wide variety of waste material, including plastics. The United States has joined that group and it soon will be against Federal law to pollute the ocean with such material. At least 30 U.S. senators were concerned enough about the problem to write to the President. They think it is time to do something about it, to stop fouling our marine nest. The President agrees. This conference is an out-growth of that concern.

Aside from their concern, is it really important? How much does anyone know about the extent and significance of the problem, if it is one? Is there information available or is it merely continuing concern by the environmental community for a cleaner environment? And what can be done about it if it really is a problem?

We are here for three days to discuss fisheries-generated plastic debris in the ocean, what the problems are, some things that have been tried, and some things still to do and how to do them. We must develop recommendations for incentive-type programs or other solutions to stop future discharges and to help remove what is already there.

Fishermen are not the major ocean polluter, but they are having an impact, and this conference is to address their part of the action.

Immense quantities of man-made waste are entering all the oceans of the world daily, and because the vast majority of it is not biodegradable, it is simply adding to what is already there and making the situation increasingly serious. Further, a large volume of the plastic debris discarded and lost at sea is negatively buoyant and disappears from sight. Industrial production of the principal synthetic compounds used in the fishing industry began in the 1940s and 1950s, and by 1970 the conversion from natural to synthetic fibers was complete for the major fishing nations of the world. The life expectancy of a piece of polyamide webbing could be up to several hundred years. Webbing from trawls in the North Pacific could be carried by currents and deposited off the Hawaiian Archipelago, Asia, or the entire Pacific coast of North America. Yet, this is a worldwide problem.

Let me talk for a few minutes about the fishing industry involvement. What occurs, why does it occur, what is the impact, and what is involved in correcting it?

First, what occurs? Most of the commercial and recreational fisheries of the world are conducted by using a variety of lines, nets, or pots, essentially all of which currently are predominantly synthetic material. This is true for the Pacific coast, Atlantic coast and Gulf of Mexico as well as all other areas where U.S. fishermen ply their trade or pursue their sport. The three kinds of fishing material usually involved in entanglement are polyethylene trawl webbing from the groundfish fisheries of the world, monofilament gill net from the high seas drift net fisheries for salmon, squid, or tuna/billfish or coastal surface and demersal gill net fisheries for a wide variety of species, and monofilament fishing line from recreational and commercial hook and line fisheries worldwide. No matter how careful the operators are, much fishing gear is lost in the ocean under conditions beyond their control. Additional material is deliberately discarded for various reasons along with shipboard supply containers. This costs fishermen money and costs many marine inhabitants their lives.

Why does this occur, particularly if it is so costly and harmful? There are two basic reasons--inadvertent and deliberate actions. Gear is lost because of hazardous fishing conditions coupled with vagaries of nature, equipment is not serviced or maintained adequately, operators at times are inexperienced or careless, and vessel operations destroy equipment in other fisheries during accidental conflicts on shared fishing grounds. Some of these inadvertent losses can be prevented or the signifi-

cance lessened by potential modifications in gear construction and overall operations. Others are uncontrollable given realistic fishing practices.

What about the deliberate? On occasion, lines, pots or nets are left on the grounds untended or unmarked for reasons best known to the operators. Pieces of gear are discarded during operations or in onboard repair and maintenance as well. In addition, a wide variety of plastic waste from vessels is thrown overboard. The deliberate discarding is done because the simplest way to dispose of something is to throw it overboard. After all, how could such a small amount in such a big ocean cause any problem? Besides, there doesn't seem to be room on the vessel to keep materials with no further use or significant value. Even if there were, how could it be readily disposed of at the dock like the catch? No, it is simpler and easier to throw it overboard when a fisherman is finished with it, not to handle it again, and to get on with more important things like catching fish and making money. Fishermen are only a small part of the problem. Let the real culprits solve it. Something as big as the ocean can take care of itself.

What is the impact? Much is known or estimated, but much more needs to be learned about the significance of the impact. Surveys have been conducted and counts and estimates made in various parts of the world regarding plastic debris discharges and resulting impacts. The U.S. National Academy of Sciences estimated that in 1972 the commercial fishing fleets alone dumped more than 5 million pounds of plastic packing material into the sea and probably lost almost 3 million pounds of plastic fishing gear, including nets, lines, and buoys. It is estimated that now there is a minimum of 1 million commercial fishing vessels in the world. Updating the 1972 estimate to 1985 with the increased number of vessels would yield an estimate of over 43 million pounds of plastic waste and almost 25 million pounds of lost fishing gear each year. That's enough to do something about!

Let me quote a few figures that are impressive, to me at least. More than 100,000 pieces of plastic per linear meter of beach were found in New Zealand according to a 1978 publication. It was estimated in 1984 that the Japanese and central Pacific salmon and squid drift net fisheries combined were losing and not recovering up to 1,624 miles of monofilament gill net annually. On October 13, 1984, 2,100 volunteers collected over 26 tons of plastic debris from Oregon's beaches. Five hundred and fifty pounds of plastic litter was added to less than a mile of beach in one year and there

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was a 250 percent increase in the number and weight of plastic items washed ashore over a two-year period on Amchitka Island, way out in the Aleutians, according to a 1980 report.

Sixty-five trawl nets or portions of nets were estimated to have been lost in foreign and joint venture fisheries in Alaska in 1983. Possibly more than 30,000 crab pots have been lost in the Gulf of Alaska since 1960 and an estimated 20 percent of legal size and 8 percent of sublegal king crab in these pots at the time of loss fail to escape. Most of these pots could still be fishing, although since 1978 the State of Alaska has required all king crab pots to have at least one mesh panel sewn to the frame with a natural fiber twine to facilitate eventual fishing power loss. Hundreds of Dungeness crab pots are lost each year from Alaska to California and many continue to fish. Fish and diving birds continued to be caught for over three years and crabs over six years in salmon gill nets after they were lost or abandoned in Puget Sound. Approximately 15 percent of the world's 280 species of seabirds are known to ingest plastic. Plastic bags have been found in the digestive tracts of four of the seven species of turtles off the United States, Central America, French Guiana, South Africa, France, Japan, Australia, and the South China Sea. A mass mortality of green turtles off Costa Rica was attributed to ingested plastic. Minke whales have been observed eating plastic from fishing vessels. Ingested plastics cause a multitude of gastrointestinal problems. One estimate is that 30,000 northern fur seals die annually from entanglement in discarded fishing gear. Entrapment in plastic materials such as six-pack holders, packing bands, wrapping materials, trawl web and other netting, and ingestion of plastic particles and materials is known to kill birds, seals, sea turtles, sea lions, and fish. Problems from the plastic in the ocean include detrimental effects on marine mammals, seabirds, sea turtles, fish and invertebrates through entanglement, entrapment, and ingestion-related damage; interference with vessel activities; and endangering recreational and commercial divers and diving vehicles.

In short, certain species of marine mammals are killed from net fragments and other plastic material around their necks, marine birds are caught in the debris and drown, crabs and fish enter lost pots and nets that are still operational and are eaten or die, sea turtles become entangled and drown, and fish, birds, and mammals ingest plastic particles resulting in death. However, notwithstanding all the mortalities of marine life known to occur, there is no indication any species of bird, mammal or

fish is endangered or threated because of the impact of plastics from entanglement or consumption. But the losses are significant and can and should be reduced.

Concentrations of lost pots and nets combined with rough bottom can make certain areas unfishable. Lost lines and nets foul propellers of commercial and recreational boats and entangle divers, and accumulations of debris litter beaches.

What can be done to improve this situation? There are three basic changes that must be made: (1) put less debris in the ocean, (2) make less harmful what we do put there, and (3) recover more of what is there. Again, the problem should be divided into inadvertent and deliberate pollution. Some of the inadvertent losses of equipment can be reduced or the adverse effect ameliorated by changes in gear composition, rigging, or operation. Other inadvertent losses will continue to be expected as part of fishing, but efforts can be made to collect at least some of the lost or discarded gear or material

Most if not all of the deliberate discard can be changed with a combination of realistic, enforceable, and enforced rules and regulations, more effective education of those involved regarding the significance of the problem and ways to minimize it, development of better handling and disposal methods, financial support of innovative concepts and experiments, and establishment of incentives to clean up the ocean including releasing less and collecting more of what is already there and disposing of it in mutually acceptable ways.

I am not saying that I have all the answers and the job can be done simply and inexpensively. However, I do believe that people of good faith who recognize that they are part of a significant problem, understand the importance of taking prompt action, participate in the decisions about changes to be made, are willing to be accountable for their own actions, and will work with others in making changes can collectively make a difference. I sincerely believe we have reached that point. All the approaches are not immediately evident, but we must start now to improve our performance and the marine environment in which we perform. We can start stopping the waste discharge at sea while developing methods to remove some of what is already out there.

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This conference has as a primary objective the development of incentive-type approaches to reduce the fishing industry contribution of plastic debris in the ocean. We have tried to bring the conference program speakers most directly involved in or knowledgeable about the problem. They include experts in fishing, biological research, waste disposal, port management, communications, plastic manufacturing, home economics, beach surveys, gear marking, enforcement, incentive programs, and legal authority and resources. One thing they all have in common is they want to help resolve the problem.

We truly want all of you present, speakers and listeners alike, to actively participate in the deliberations in the next couple of days to develop workable recommendations for the domestic Policy Council. We have an obligation to provide recommendations and we will meet that commitment. Please help us make them the best possible concepts that we and they can live with and support.

There have been two conferences recently in Hawaii on ocean debris problems, one in 1984 and another in 1987. They have helped greatly in surfacing existing knowledge and developing research, study, and solution. Information from them has contributed significantly to the planning of this meeting. Now let's get on with the productive and informative part of our program.

APPENDIX B

Background Paper for a National Workshop on Fisheries-Generated Marine Debris and Incentive-Based Regulatory Systems

Xanthippe Augerot, Washington Sea Grant

Marine debris has over the past few years become an issue of national and international importance and interest. The United States recently ratified Annex V of the International Convention to Prevent the Pollution from Ships (MARPOL) and enacted domestic implementing legislation. When the new law goes into effect next year, regulations governing the dumping of routine shipboard wastes will become much more stringent. The disposal of plastics at sea, including fishing nets and line, will be prohibited.

The recent upsurge in attention stems from an increased accumulation of marine debris and increased public awareness of the aesthetic and environmental damage it causes. This increased accumulation is in part the result of the use of persistent materials, especially plastics. An indication of the broad public interest in this issue is the April 2, 1987 letter to the President of the United States from 30 U.S. Senators outlining the potential impacts of marine plastic debris on marine resources, safety, and enjoyment of the marine environment. The Congressional letter calls for federal interagency cooperation to combat marine plastic debris from all sources, including investigation of the use of more rapidly degradable materials and bounties or other incentive systems to increase the retention and retrieve rates for plastics such as derelict fishing gear.

This conference is, in part, a response to that letter. Our major focus is on fisheries-generated marine debris and means to reduce its flow and mitigate its impact on the marine environment. We will examine the range of mitigation options, from education to incentive-type regulation. The fishing industry in the Pacific Northwest and Alaska has taken a leadership role on this issue, led by the Highliners' Association in Seattle. They have participated in industry education projects at home and abroad to increase awareness of marine debris problems in the fishing industry. We would like to build upon their initiative, and carry their message to the fishing in-

dustry in other parts of the nation as well as to other waterborne contributors to the problem--especially the merchant fleet, recreational boaters and sportfishermen.

In some coastal regions of the United States, especially in the Pacific Northwest and Alaska, the fishing industry is among the major contributors of persistent debris to the marine environment. In other regions, much of the persistent plastic debris originates from the recreational fishing and boating community, from the merchant shipping fleet, the federal military and oceanographic fleet, the offshore oil and gas industry, and land-based sources. To date, the effects of marine plastic debris have been most thoroughly documented in areas with significant marine mammal populations, such as the Pribilof and Aleutian Islands in Alaska (fur seals, sea lions), California (harbor seals, sea otters), and Hawaii (monk seals). This is due in part to the fact that marine mammal entanglement problems are more visible than the other effects. They are easier to research than habitat impacts, the impact of plastic ingestion upon birds and other marine life, and ghostfishing.

It is convenient to examine the marine plastic debris issue by breaking the problem down into a discussion of exposure pathways, effects, and potential mitigation measures, as was done by the National Marine Pollution Program Office's (NMPPPO) Persistent Marine Debris Working Group (see Figure 1). By breaking down the problem in this fashion, it is easier to assess research needs and address areas where mitigation measures can be undertaken.

In 1987, the NMPPPO Working Group developed a prioritized list of marine debris research needs. Out of a list of thirteen priorities, four addressed the need to research and develop mitigation measures to reduce the volume of fishery-source debris or lessen its effects. In October of 1987, the participants in the North Pacific Rim Fishermen's Conference on Marine Debris (industry and government representatives from the United States, Japan, South Korea, Taiwan and Canada) identified a number of research needs specifically related to fisheries-source debris. Of the nine research areas discussed, five are mitigation needs:

- identification of gear types which could be made with less harmful materials and/or alternative operating procedures reducing likelihood of gear loss and environmental harm;

- assessment of the feasibility of and impediments to recycling of used fishing gear and other vessel-generated wastes;
- improvement of shoreside waste reception and management facilities;
- development of shipboard waste-handling technologies such as compaction or safe incineration techniques; and
- the examination of cost-effective gear-making and gear-return systems.

Research on mitigation approaches has been slow and piecemeal so far, funded largely by the ambitious National Marine Fisheries Service (NMFS) Marine Entanglement Research Program. Projects have included research on degradable materials; investigations of current shipboard waste handling practices and options such as incineration; evaluation of plastic recycling systems; and a port debris reception facility demonstration project, based at the Port of Newport, Oregon. Most of this research is not fisheries-specific, rather it is targeted at all waterborne sources of plastic debris. In some cases, the fishery component of research projects is very slender due to the lack of relevant data on fishing fleets and operating practices. If public education is counted as a mitigation activity, this portion of the Marine Entanglement Program accounts for a little under 25% of its \$750,000 budget (Coe and Bunn, 1987).

Although, as noted at the Pacific Rim Fishermen's Conference, additional research is needed on plastics recycling, degradable plastics, safe incineration techniques, and port reception facilities, much can be done to mitigate the effects of marine plastic debris by changing people's attitude and behavior. Skippers, crews and boat owners, as well as port personnel, provisioners, and processors, need to be aware of the effects of their waste-generating and handling habits and begin to change them. Such change can be brought about by a combination of education, peer pressure and regulation.¹ This discussion will focus on incentive-creating regulatory systems.

¹On December 30, 1987 the President signed a bill which addresses these issues (P.L. 100-220). It contains provisions to implement Annex V of MARPOL and addresses the issue of highseas drift gillnet fisheries in the North Pacific. It includes funds for education, regulatory enforcement measures, and studies of degradable plastics, net retrieval bounty systems, and net marking and tracking systems. This legislation will be addressed in a companion legal analysis by Casey Jarman.

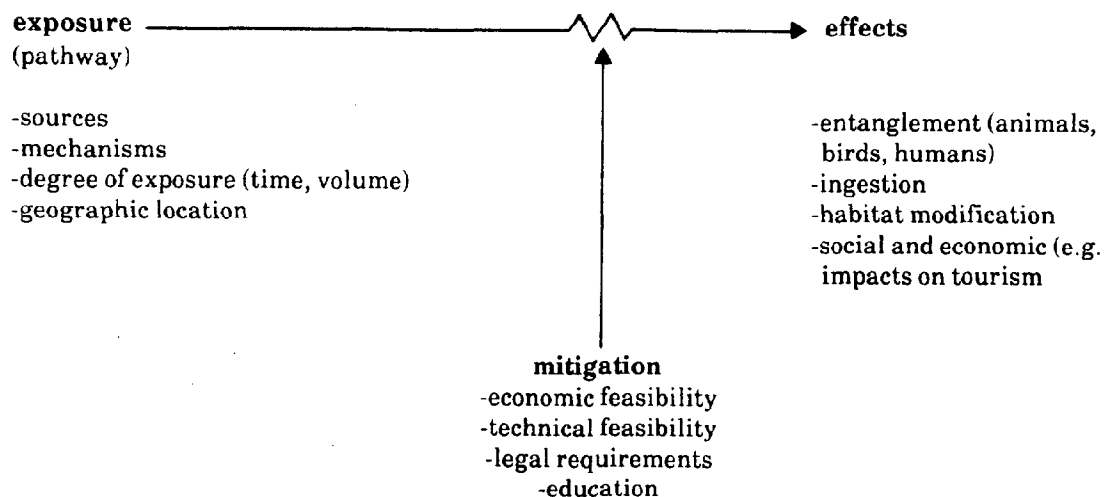


Figure 1. NMPPO framework for assessing the persistent marine debris problem.

Adapted from: National Marine Pollution Program Office (NMPPO) Persistent Marine Debris Working Group. 1987. Draft Summary Document produced at the Workshop on National Marine Pollution Problems and Needs. NOAA, NMPPO, 6010 Executive Boulevard, Rockville, Maryland, 11 June 1987.

INCENTIVE SYSTEMS

Ideally, economic incentive regulatory regimes change the behavior of regulated parties by restructuring the choices they face. They are designed to induce certain types of behavior which are thought to be more socially desirable than those which are made in the absence of regulation, or under a traditional command and control regulatory regime. The most common incentive systems range from the familiar-- parking meters creating a market for parking spaces instead of placing a ceiling on the number of cars in an area, tax breaks for home insulation to encourage energy conservation--to the more novel-- tradeable emissions permit systems for air or water pollution control creating a quasi-market for the right to pollute.¹ The best documented uses of incentive systems in natural resource management to date have been for tradeable air and water pollution emission permits (Liroff, 1985 and David and Joeres, 1983) and energy pricing to promote conservation (Nemetz and Hankey, 1984).

Incentive systems have some obvious advantages. They decentralize decision making. If a plant wants to pollute at a certain level, it can, subject to the availability of the appropriate number of pollution permits. Another example is bottle-deposit legislation. Once a bottle deposit system is instituted, everyone pays a deposit for the bottles he buys and may choose to return the bottle for a rebate or forego it as he wishes. More bottles are returned for reuse or recycling than in the absence of the program, and the uncollected bottle deposits help to finance the system. Incentive systems can also be said to be more economically efficient. Each individual decision maker chooses his or her own compliance level according to their own capabilities, rather than facing a uniform standard which may be simple for some to attain and put others out of business. It is societally efficient, in that those most capable of changing their mode of operation do so at the least cost (Schelling, 1983).

Experience with incentive systems has demonstrated that enforcement issues are still a major problem (Elkin and Cook, 1985). Particular attention must be paid to creating adequate financial incentives for compliance, assuring that familiar or previously tested administrative mechanisms are used whenever possible, that exten-

¹Individual transferable quota (ITQ) limited entry systems can also be classified as quasi-market incentive systems, inducing fishermen not to over fish.

sive public education programs be carried out about the program and its goals, and that industry and community leaders be drawn into the formulation and implementation of the program from the beginning (Nemetz and Hankey, 1984).

FISHERIES INCENTIVE SYSTEMS

There is no history of the use of incentive systems in fishery management, other than the disincentive to break the law created by fishery regulations and penalty structures. In the Driftnet Impact, Monitoring Assessment and Control Act of 1987, the U.S. Congress mandated studies to determine the feasibility of a bounty system for the retrieval of derelict driftnets and to determine the feasibility of a net-marking, registration and identification system. Net marking, in conjunction with a system of strict liability for any damages to vessels or wildlife caused by fishing gear, would be a strict-type incentive system. Careless handling of gear or net fragments could lead to large fines, and lost gear may be more likely to be retrieved, especially if it posed a risk to other fishermen.

These ideas have been proposed in the context of the foreign high seas drift gillnet fishery in the North Pacific. They may be applicable to some domestic fisheries as well. The fisheries which are of greatest concern are the trawl fishery in the North Pacific (implicated in the decline of the North Pacific fur seal and possibly the northern sea lion population), gillnet fisheries, and trap fisheries (due to the propensity of these types of gear to continue to fish when lost) around the country. All gear types contribute to the problem to some degree, as it has long been customary for seafarers to throw their trash overboard. With the increasing proportion of plastic packaging, every fisherman or boater who throws his garbage over the side is part of the problem.

The most dangerous types of household trash are plastic bags and six-pack yokes for beverage containers. Plastic bags do their damage when they are eaten by sea turtles and marine mammals, while six-pack yokes strangle both marine mammals and seabirds. All gear groups contribute when they do net repair at sea. Chances are that some of the net and line fragments or packaging material used to wrap parts will go over the side. Sometimes dumping is deliberate--there is simply not enough space on board for all of the scrap and other trash--or it may be accidental. Plastic sheeting

and pieces of rope and line may be swept overboard during heavy weather. Gear may also be lost after it is set during heavy weather and be irretrievable.

No fisherman wants to lose gear. It is expensive and inconvenient to replace when out on the fishing grounds, adding an extra cost in lost fishing time. The types of fishery-generated trash which can most readily be decreased in volume are thus gear fragments and routine household trash.¹ Data on gear loss and discards are sparse, but best for the North Pacific due to National Marine Fisheries Service foreign fishery observer records (Low et al., 1985). See Figure 2 for a regional breakdown of the fishing industry's perceived contribution to marine debris problems in different parts of the United States.² Incentive systems designed to change the behavior of the fishing fleet could take a variety of forms, from the simple to the elaborate:

1. A bounty system for the retrieval of lost or discarded gear, regardless of initial ownership. Such a system could be funded from the federal treasury or by some form of fishery user fee.
2. A net deposit-refund system, patterned after bottle bill legislation.
3. A combination voluntary net tracking, recovery and reward system, funded by some form of dues flowing to a central fund. Anyone recovering gear would receive a cash bonus, after collection and handling costs had been reimbursed to the port, processing plant or other shoreside disposal agent. After year's end an award could be given to the fisherman retrieving the most gear or gear fragments, or a raffle could be held for an award among all gear retrievers. If the fisherman recorded the loss in a logbook and the gear was marked, he would also receive a small compensation. This would create an incentive to keep a logbook and identify one's gear. Such a system could be governmentally or non-governmentally run, and would generate data on gear loss patterns and trends.

¹There is one exception. Due to the derby-style fishing seasons in Alaska, longline gear is often cut and abandoned at the end of a short opening. It may continue to ghostfish for a long period of time. This is a problem that can be addressed only through changes in fishery management, that would eliminate the incentive to fishermen to abandon gear when the opening ends.

²The information in this table was provided by Sea Grant marine advisory agents in the various regions. It is a first cut, and may be incomplete.

4. An inventory system, recording all gear purchased and taken aboard a particular vessel. If gear was not returned to shore within some pre-specified time, a "deposit" would be paid by the vessel owner or operator. If the gear was eventually returned, a portion of the deposit would go to the retriever, a portion to the shoreside disposal agent and, *if* the gear was marked, a portion would go to the original gear owner. This system has the advantage of no front-end monetary outlay, and would also generate data about gear loss. However, the inventory system required would be so burdensome as to make the system infeasible.

Any of these systems would have to be international in scope in order to be effective, especially in the North Pacific fisheries. Each would have to be modified to accommodate varying gear types and regional fishery-generated marine debris problems.

Each system would also have to be carefully reviewed for abuse potential. Creating a monetary incentive to bring derelict gear back to shore will likely spawn attempts to maximize the amount of bounty claimed in ingenious ways that are counter-productive to the objective of reducing marine plastic debris in a cost-effective manner.

The most straightforward incentive system to address the problem of derelict or discarded fishing gear would be patterned after bottle deposit-refund systems. In economic terms, a deposit-refund system is composed of a package of taxes (deposits) on certain kinds of transactions or the purchase of particular commodities and subsidies of (refunds for) particular forms of behavior with respect to consequences of initial transactions (Bohm 1981). It is more appealing than a bounty system because it can be self-financing, and it will reach every fisherman. Education is implicit in the system, as the rationale must be explained every time gear is purchased and a deposit paid. Analogous to the bottle deposit system, the goal is to discourage inappropriate disposal or loss of bottles, or fishing gear, in order to reduce environmental damage and negative aesthetic impacts. It is a transferable incentive mechanism as well--anyone who comes across nets, webbing, lines or pots at sea can benefit by collecting the lost gear and returning it to shore.

REGION	EXPOSURE	EFFECTS
Oregon and Washington	<u>crab fishery (Dungeness)</u> -crab pots lost in storms -plastic bait bags discarded -poly line discarded -floats lost or washed overboard -vessel-generated household trash*	Ghostfishing, beach debris
	<u>longline fishery (halibut, black cod)</u> -poly line, plastic sheeting lost -overboard, household trash	Ghostfishing by lost longlines, beach debris
	<u>gillnet fishery (salmon, thresher shark)</u> -floating nets, discarded fragments, household trash	Ghostfishing, beach debris
	<u>troll fishery (salmon, albacore, rockfish, lingcod)</u> -styrofoam bait containers, monofilament lines broken or discarded -plastic sheeting washed overboard -household trash	Beach fouling
	<u>trawl fishery (shrimp, groundfish)</u> -net fragments discarded or washed overboard -poly line lost or discarded -net floats lost or snagged -plastic sheeting washed overboard - household trash	Ghostfishing (mammals and fish), beach fouling
	*vessel-generated "household trash": intentional discard of worn or torn net fragments, chafed lines and faulty deck or processing equipment, plastic packaging from bait packs, wire packs, old engine parts, paint cans, hydraulic hoses, etc. Also galley wastes and personal items. Unintentional gear loss--"derelict gear."	"Human" entanglement: primarily trawl webbing and all types of rope and line, in propellers. Expensive in time and \$\$\$. Plastic sheeting, bags and netting foul troll and longline sets. Costly in terms of time. Sheeting and bags clog engine intakes. Lost crabpots and trawl gear snag and harm fishing gear, e.g., trawl net tear-ups.

CURRENT MITIGATION:

Port of Newport Marine Debris Demonstration Project. The fishing community and community at large are cooperating to demonstrate the feasibility of carrying trash back to shore rather than dumping at sea.

Figure 2. Regional Differences.

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REGION	EXPOSURE	EFFECTS
Alaska	<p>Fishing industry is the major contributor. All vessel types contribute household trash.</p> <p><u>crab fisheries</u> -pots lost to ice, stormy weather, sea lions; prop-cut buoy lines</p> <p><u>longline fisheries</u> -longlines hung up on hard bottom or other gear; abandoned at closure; moved and lost in heavy weather</p> <p><u>gillnets and seines</u> -abandoned in heavy weather, hung up on hard bottom</p> <p><u>trawl fisheries</u> -codends lost during joint venture codend transfer, tear-ups on hard bottom, snags or other lost gear such as derelict trawls or crab pots</p>	<p>For all gear types: entanglement of fur seals, sea lions, seabirds. Disruption of benthic habitat may affect shellfish and bottomfish. fouling of props, engine intakes and gear sets. Beach fouling.</p>
California	shipboard trash, gillnets	<p>Beach fouling and entanglement. Entanglement of marine mammals esp. sea otters and seabirds; ghostfishing.</p>

CURRENT MITIGATION:

Time and area closures or gillnet fisheries in areas of high seabird and marine mammal concentration.

New

England household trash, lobster traps monofilament gillnets (minor contribution from other gear groups-- trawl, longline, seine)

Beach fouling affects coastal tourism, esp. in New Jersey. Fishing gear is observed on beaches. Ghostfishing is primary issue of concern, esp. by lobster pots and gillnets.

Commercial fishing industry considered a minor part of the problem. North of Atlantic gyre, there is less transport of off shore-generated trash onto beaches. More debris from land-based sources--landfills, sewage systems, dumping, etc. Recreational boaters, shipping and tourism are major contributors.

CURRENT MITIGATION:

Biodegradable panels required in lobster pots in Maine. Requirement may be adopted by New England Fishery Management Council (NEFMC) for all New England lobster fisheries.

Figure 2. Regional differences cont'd.

REGION	EXPOSURE	EFFECTS
Gulf of Mexico	<p><u>otter trawls (shrimp fleet)</u>-- lost primarily due to snags and tear-ups on hard bottom and retired oil rigs and other debris household trash, gillnets, crab pots</p>	<p>Possible ghostfishing problems with pots, gillnets, trawl gear, but don't really know. No marine mammals to serve as obvious visible signal of distress. Sea turtles harmed by ingestion of plastic bags and other types of plastic material. Birds entangled in monofilament line from recreational and commercial hook and line fisheries. Beach fouling negatively affects the tourist industry. Plastic bags and line foul props and engine intakes.</p>

Fishing industry part of the problem, relative contribution varies over region. Merchant fleet, oil and gas industry, recreational fishing and boating, shore-based sources are all contributors. Sources difficult to determine. Western Gulf of Mexico coastline receives large deposition of trash due to the action of the currents and the sheer volume of vessel traffic in the Gulf.

PROPOSED MITIGATION:

Designation of the Gulf of Mexico as a "special area" under MARPOL Annex V, which would allow the dumping of food wastes at 12+ miles and ban all other garbage dumping completely.

Figure 2. Regional differences cont'd.

How might such a system work?

- Fishermen would pay deposits on gear (trawl, seines, gillnets, pots or traps, longlines, etc.) at the point of purchase.
- The transaction would be recorded: type of gear, amount of deposit, fishing vessel, f/v owner name and address, etc.
- The deposit would depend on gear type, cost, propensity to cause damage to marine wildlife or foul beaches, etc. It would be assessed by the gear vender per pound per square foot of gear.
- Deposits would be paid into a regional NMFS or Coast Guard account (whichever agency is authorized to administer the program).
- Gear would be returned to shore for collection of refund either by the original purchaser and user or by the retriever of the cost or discarded gear.
- Net fragments or portions of line would be counted either in units of square footage or by weight, and refunds made accordingly.
- In areas of high concentration of small vessels, mobile units would collect debris returned to shore and take them to central collection point for separation into recyclable and non-recyclable goods. For example, webbing useful to aquaculturists could be separated out for reuse. All reusable components would presumably be stripped by retrievers (floats, cables, hooks, etc.).¹
- Large vessels or floating processors, etc., may truck their own materials to a central collection point, due to the larger volume of used gear generated.

¹The Port of Newport's experience would be instructive here, as they have been able to recycle a good deal of the debris returned to shore by the fishing fleet. Newport's experience that an integrated waste management facility works best should also be kept in mind, so as not to duplicate services and complicate compliance.

- The collection agency operating mobile and central collection units would record returns and begin processing refunds. Refund checks would go out (from the central CG or NMFS office) by mail.
- The collection agency and mobile units could either be government-run, government contracted, or left to private service providers.
- The refund level could be set to equal the deposit, or deposit plus partial payment of interest accrued.
- A statute of limitations must be set on the collection of refunds to discourage net hoarding and the accrual of exorbitantly high interest. Two years might be a reasonable length of time, or different periods could be set for different types of gear dependent on average functional lifetime.
- Precautions would have to be taken to deter abuse of the system. A black market in non-deposit gear could develop, resulting in the system paying out while losing out on the deposit income.

Not all gear purchased would be returned, and interest income could be earned on the deposit refund. Thus the system could be self-financing. An additional benefit of the system may be to spur the plastics industry to develop recycling technologies to use on poly gear. An early Environmental Protection Agency study (Milgrom, 1972) on incentives for plastic recycling concluded that one of the major obstacles was economic. Collection of large quantities of recyclable material was prohibitively expensive. A gear deposit system would generate a steady flow of material to central collection points, and perhaps decrease the risk to the plastics industry of developing a new recycling technique and markets for new products.

A deposit-return system could be used alone, or in conjunction with a net marking system to pinpoint liability in the case of damage caused by derelict gear in the form of fouled propellers, clogged water intakes or strangled fur seals. However, it is highly unlikely that fishermen would voluntarily undertake to establish a net marking and tracking system, and this would have to be mandated by law. There are also significant practical problems to contend with in this regard. Pots and longline

PUBLIC	QUASI-PRIVATE	PRIVATE
Federal treasury	-Landing fees	-Association dues
State treasury	-State or federal fishing licenses -Gear taxes -Net deposits (if government run)	-Net deposit (if privately run) -Private grants

Figure 3. Overview of financing options for incentive systems.

gear (floats) may be fairly easy to mark. Trawls, gillnets and seines on the other hand, could be very difficult to mark thoroughly.

Most gear, regardless of manufacturer and national origin, is generic in appearance. Sophisticated systems such as wire-coded tagging could in theory be used, but may be a logistical nightmare to track. The cheapest point of installation into webbing would be at the twine manufacturing level. However, the same lot of twine or web would eventually be used for many items of fishing gear. A great deal of recordkeeping would be required to track individual lots and the resulting products. In addition, fishermen actively trade gear or resell it on the fishing grounds according to their needs. At this level, ownership of particular items of fishing gear would be very difficult to track in anything other than a crude manner.

POTENTIAL INCENTIVE SYSTEM FUNDING MECHANISMS

So far the issue of funding has been peripheral to this discussion. Although the net deposit system as presented here is presumed to be government-initiated and administered, it could be wholly or partially funded by the fishing fleet. Funding options range from wholly public to wholly private (see Figure 3). For example, a bounty could be financed fully from federal or state treasuries, or by dues collected from fishermen's associations. Most "user fee" or industry financing options are quasi-private in that they draw upon private funds, but are administered expenses incurred). Post user fees could be levied to cover shoreside debris handling costs. The combination of

financial mechanisms chosen is a political choice, reflecting societal feelings as to responsibility for minimizing marine debris and feasibility of administration.

CONFERENCE GOALS

The task before this group is to reexamine the commercial fishing industry's contribution to the marine plastic debris problem and discuss the feasibility and practicality of government-sponsored incentive systems to get the industry to change its behavior. Rather than looking at an incentive system as the only solution, we will also share our knowledge about public education programs that work, discuss the evolving technology that may help to reduce the loss of synthetic fishing gear and discarded plastic trash, and technology such as degradable materials which may mitigate the effects of plastic debris once it is in the ocean. Recommendations about the feasibility and desirability of regulatory incentive systems will be made after assessing what is happening in the U.S. fishing industry now, and what it can do to help itself.

REFERENCES

- Augerot, X. 1988. Plastic in the ocean: What are we doing to clean it up? WSG-AS 88-6. Washington Sea Grant, 3716 Brooklyn Ave. N.E., Seattle, WA 98105.
- Bohm, P. 1981. Deposit-refund systems: theory and applications to environmental conservation and consumer policy. Baltimore: Johns Hopkins University Press.
- Coe, J. and A. Bunn. 1987. Description and status of tasks in the National Oceanic and Atmospheric Administration's Marine Entanglement Research Program for fiscal years 1985-1987. Seattle: NOAA, NMFS, NWAFC Processed Report No. 87-15.
- David, M.H. and E.F. Joeres. 1983. Is a viable implementation of TDP's transferable? Paper prepared for Sea Grant Institute conference on Regulatory Reform, Transferable Permits and Enhancement of Environmental Quality, June 23-25, 1982, Madison, WI. In David and Joeres (eds.), *Buying a better environment*. Madison, WI: University of Wisconsin Press.

40 *Oceans of Plastic Workshop*

Elkin, S.L. and B.J. Cook. 1985. The public life of economic incentives. *Policy Studies Journal* 13(4):797-813.

Liroff, R.A. 1985. The bubble policy and emissions trading: the toil and trouble of regulatory reform. Washington, D.C.: Conservation Foundation.

Low, L. L., R.E. Nelson and R.E. Narita. 1985. Net loss from trawl fisheries off Alaska. In R.S. Shomura and H.O. Yoshida (eds.), *Proceedings of the Workshop on the Fate and Impact of Marine Debris, 27-29 November 1984, Honolulu, Hawaii*. NOAA, NMFS, SWFC Technical Memorandum No. 54.

Milgrom, J. 1972. Incentives for recycling and reuse of plastics. Prepared by Arthur Little Company for the Environmental Protection Agency. EPA Solid Waste Series 41c-72 (NTIS fiche # PB214-045).

Nemetz, P.N. and M. Hankey. 1984. *Economic incentives for energy conservation*. New York: John Wiley and Sons.

Schelling, T.C. 1983. *Incentives for environmental protection*. Baltimore: Johns Hopkins University Press.

APPENDIX C

Background Paper A Review of the Legal Structure Enabling Federal or State Enactment of the Various Types of Incentive Systems

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Litter, long recognized as an aesthetic (and occasional health) problem on land, is now taking its toll on the ocean. The most serious problem is caused by synthetic debris that does not break down easily in the marine environment. Although the sources are many and varied, they all can be traced to man's activities. Fisheries is no exception. Litter on the ocean, however, is not only a problem of aesthetics, but also poses a threat to the lives of marine animals. One recent study reported in the January 1987 issue of the *National Fisherman* indicates that an estimated two million seabirds and 100,000 marine mammals are killed every year as a result of lost or discarded plastics. Ocean litter can also wreak havoc with vessel propellers and engine cooling systems that are becoming increasingly fouled by marine debris.

The problem of ocean litter in the form of plastic debris is a complex one, with ample evidence that the problem has reached crisis proportions (Congress termed the problem a crisis in 1985), but insufficient data to determine which sources of pollution bear what percentage of the burden. However, it is clear that replacement of nets made from cotton, flax, or hemp with monofilament plastic nets which persist in the marine environment has added to the problem of loss of marine life. Derelict nets which are lost or discarded by fishing vessels can continue to "ghost fish" for periods of several years (High, 1985). Members of the fishing industry, together with researchers, legislators, and government agency personnel, are working to develop realistic solutions to the problem. A strategy being proposed at this Sea Grant-sponsored workshop involves the establishment of a net deposit-refund system similar to bottle and aluminum can recycling programs. (See discussion earlier in this briefing paper for a detailed description of the proposed system.) Such a system will require the delineation of legal duties among those involved in the system. The first question is whether any laws currently exist to implement it. Second, if more than one law is available, which one is the most appropriate? Third, if existing authority is insufficient, what legal mechanism is necessary to provide a framework for implementation? This section of the briefing paper addresses these three questions.

EXISTING LEGAL STRUCTURE

A. Ocean Dumping Act

The Ocean Dumping Act addresses the dumping of waste and other materials into the ocean. (Title I of the Marine Protection, Research, and Sanctuaries Act, 33 U.S.C. 1401 et seq.) It establishes a permit system for transporting materials for the purpose of disposing them in the ocean. Permits for two types of activities must be secured from the federal Environmental Protection Agency (EPA): (1) transporting from the United States to dump into the U.S. territorial sea, U.S. Exclusive Economic Zone (EEZ), or on the high seas; and (2) transporting from outside the United States to dump into the U.S. territorial sea and a contiguous zone out to 12 miles from the coast.

Because the Act implements the London Dumping Convention, it must be read in light of the Convention. (Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matters, 26 U.S.T. 2403). The Convention covers the intentional disposal of materials at sea; it expressly excludes disposal incident to normal vessel operations. It is likely, then, that the accidental loss of fishing gear at sea is not regulated by the Ocean Dumping Act or the Convention. Read broadly, the deliberate disposal of nets and other gear into ocean waters is illegal without a permit.

But is the Act sufficiently broad to allow the EPA to institute a net deposit-refund system? Without specific amending language, it is doubtful. The Act clearly envisions a disposal scheme and provides EPA with authority to establish a permit system, as well as to promulgate any regulations appropriate to carry out this authority. Although a net deposit-refund program would complement the permit system, there is no indication that Congress gave EPA the general authority to propose its own regulatory agenda, separate from permitting, to deal with ocean disposal problems.

B. Federal Water Pollution Control Act

The Federal Water Pollution Control Act (FWPCA), known also as the Clean Water Act, represents an attempt by Congress to deal comprehensively with the problems

of water, including marine, pollution (33 U.S.C. 1251 et seq.). Its complex regulatory scheme, administered by the EPA, is designed to deal mainly with pollution problems arising from land-based activities. Various permitting schemes controlling the discharge of pollutants into U.S. waters are established by the FWPCA.

Although discarded fishing gear fits into the Act's definition of the term "pollutant," the deliberate or negligent loss of nets and other gear at sea is not controlled by the permit programs. Section 1311 makes illegal the discharge of pollutants without the requisite permit. However, the FWPCA's definition of "discharge of pollutants" specifically excludes the addition of pollutants from vessels into the ocean [33 U.S.C. 1362(12)].

In addition to the permit program, the FWPCA includes a section providing liability for the discharge of hazardous substances into U.S. waters. It establishes a "no discharge" policy for hazardous substances in U.S. waters when such discharge would affect fishery resources (33 U.S.C. 1321). For the purposes of this section, Congress has given the term "discharge" a meaning broad enough to encompass the act of discarding fishing gear. However, unless the term "hazardous substances" can be construed to include netting and other fishery-related debris, this section, too, is inapplicable to the debris problem. EPA's current list of regulated hazardous substances, along with the Act's definition of hazardous substances as "elements or compounds," makes it likely that discarded gear is not covered.

While the FWPCA gives the EPA extensive responsibilities in regulating water pollution, no clear authority exists under the Act for establishing a net deposit-refund system. Rather the Act is directed toward more traditional types of pollution resulting from land-based activities. Without amending language, then, the FWPCA does not provide the necessary framework for implementing a net deposit-refund system.

C. Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) establishes a general moratorium on the taking and importation of marine mammals (16 U.S.C. 1361 et seq.). For purposes of the Act, the term "moratorium" means a complete cessation of the taking of marine mammals ... except as provided in this chapter, "take" means to attempt to or

to harass, hunt, capture, or kill; and "marine mammal" means mammals that are morphologically adapted to or primarily inhabit the marine environment. The statutory moratorium is not absolute, however. Under certain enumerated circumstances, permits may be issued for the taking of marine mammals whose populations have not been deemed depleted. Included in this permit exception are those taken incidental to commercial fishing operations. "Incidental catch" is defined as "the taking of a marine mammal (1) because it is directly interfering with commercial fishing operations, or (2) as a consequence of the steps used to secure the fish in connection with commercial fishing operations," (50 C.F.R. 216.3). It is unlikely that this exception would be read broadly enough to encompass the deliberate or negligent disposal of fishing nets and other gear at sea.

Technically, then, a person whose discarded net entraps marine mammals is in violation of the MMPA. Realistically, though, enforcement of the Act against one whose lost net is adrift is impossible without some means of identifying the owner. The MMPA intuitively would seem to be a logical vehicle for implementing a net deposit-refund system. Its goal is elimination of the unnecessary killing of marine mammals. The National Marine Fisheries Service (NMFS), which is primarily responsible for administering the Act, is well acquainted with the fishing industry and their problems. Arguably, authority exists under the MMPA to establish a net deposit-refund system. Sections 1401 and 1402 of the Act create a Marine Mammal Commission responsible for conducting scientific, legal, and policy studies to determine the best methods for protecting and conserving marine mammals. As part of this responsibility, the Commission is directed to recommend any additional measures it finds "necessary or desirable to further the policies" of the MMPA. The Secretary of Commerce (NMFS' parent agency) must respond to any recommendations made by the Commission within 120 days of receipt thereof. If it chooses not to adopt such a recommendation, it must give the Commission a detailed explanation for its decision.

If the Commission were to find, after sufficient study, that a net deposit-refund system furthered the goals of the MMPA and recommend that NMFS institute such a system, it appears that NMFS has the authority to adopt it without the need for further enabling legislation.

In addition to the above, the MMPA also specifically directs NMFS to undertake research to reduce the incidental taking of marine mammals in connection with commercial fishing operations (16 U.S.C. 1381). It also authorizes the agency to adopt regulations that would further this goal. Since a net deposit-refund system is designed to help reduce the accidental kill of marine animals by derelict nets, NMFS arguably has the authority to establish such a regulatory program.

D. Endangered Species Act.

The Endangered Species Act (ESA) provides a means whereby endangered and threatened species and the ecosystems upon which they depend may be conserved (16 U.S.C. 1531 et seq.). Once a species has been officially listed as endangered or threatened, it is illegal for any person subject to the jurisdiction of the United States to take it within the U.S. territorial sea or on the high seas. "Take" is defined broadly to include attempting to or actually killing, trapping, harming, capturing, or wounding [16 U.S.C. 1532 (19)]. As with the MMPA, an exception to the taking ban is provided for incidental takes (16 U.S.C. 1539). It is unlikely that this exception would in reality provide any relief for commercial fishermen because any more restrictive provisions of the MMPA take precedence over the ESA (16 U.S.C. 1543).

Because the Endangered Species Act is limited to only those species which are in danger of extinction throughout all or a significant portion of their ranges, its scope is not broad enough to deal with the overall problem the net deposit-refund system is designed to help alleviate.

E. Magnuson Fishery Conservation and Management Act

Passage of the Magnuson Fishery Conservation and Management Act (MFCMA) in 1976 revolutionized fisheries management in the United States (16 U.S.C. 1801 et seq.). It establishes Regional Fishery Management Councils which are responsible for developing fishery management plans consistent with seven enumerated national standards. These plans must include conservation and management measures designed to prevent overfishing while simultaneously achieving, on a continuing basis, the optimum yield from each fishery.

The MFCMA regulates both domestic and foreign fishing within the U.S. 200-mile EEZ. Foreign fishermen must get a permit to legally fish within the EEZ. Pursuant to such a permit, the operator of a foreign fishing vessel (FFV) is prohibited from deliberately abandoning fishing gear in the ocean (50 C.F.R. 611.12). In addition, accidental loss of gear must be reported to the U.S. Coast Guard. Whenever a FFV encounters derelict gear, the type and location of the articles must also be reported. Similar restrictions do not currently exist for domestic fisheries.

Could a net deposit-refund system be implemented via the MFCMA? If its sole purpose were to protect marine mammals, probably not. On the other hand, alleviating the problem of ghost fishing, vessel, or gear entanglement are sufficient reasons for regulation. But the Act's emphasis on managing species independently makes it a poor legal vehicle for implementing a nationwide fishing industry net deposit-refund program.

F. Solid Waste Disposal Act

The Solid Waste Disposal Act (now merged with and part of the Resource Conservation and Recovery Act) recognizes that "alternatives to existing methods of land disposal must be developed since many of the cities in the United States will be running out of suitable solid waste disposal sites within five years unless immediate action is taken," (42 U.S.C. 6901 et seq.). Rather than directing the EPA to establish an enforceable uniform nationwide solid waste disposal and recycling program, the Act authorizes the EPA to provide technical and financial assistance to the states to develop their own programs. It envisions the development of solid waste management plans at the state level consistent with federal guidelines. The goals of these plans are to reduce the amount of waste disposed of as well as environmentally sound disposal practices.

The Act as it stands enables the EPA to conduct and fund studies regarding the feasibility and desirability of programs such as a net deposit-refund system and to direct the states to consider such an option. However, it does not provide direct authority to the EPA to establish a national system.

Of the federal legislation reviewed above, the Marine Mammal Protection Act is the one most suitable for establishing a net deposit-refund system. On its face, the Act

appears to provide NMFS with sufficient authority to promulgate regulations implementing such a program. Both the goals of the MMPA and the mission of the NMFS are compatible with this exercise of authority. In addition, a net deposit-refund system is consistent with Congressional policy of reducing solid waste and promoting environmentally sound disposal methods as expressed in the Solid Waste Disposal Act. Furthermore, acting through existing legislation circumvents the problems of delay and political gamesmanship inherent in passing a new law.

ESTABLISHING NEW AUTHORITY

In the absence of clear, express statutory authority, federal agencies may be unwilling to develop a legally enforceable net deposit-refund system. Congress would then have to enact legislation providing the framework for such a program. Individual states also may be motivated to institute a fisheries gear recycling program. The following section discusses federal and state legal vehicles for establishing a net deposit-refund system.

A. Federal Law

The most efficient way of instituting a gear recycling program is to amend an existing statute and grant the administering agency specific authority to develop a program. Of the laws discussed above, two seem particularly suited for ocean litter and are managed by agencies with expertise in the field of pollution. In addition, both statutes require that research be undertaken to obtain better data upon which strategies to reduce marine pollution can be based. The existence of these research programs gives Congress and the agencies another alternative. If there is hesitancy to establish a nationwide net deposit-refund program, Congress could mandate a pilot recycling program to determine the effectiveness of the proposal prior to adding another regulatory responsibility on an already overburdened bureaucracy and public.

The next question to be addressed is which statute and/or agency is better suited to administering such a project. Although the EPA has a significant amount of expertise in the more general field of pollution, NMFS has available to it that knowledge plus an understanding of fisheries management. NMFS has a program in Seattle with staff working specifically on the issue of marine debris and which is

studying, among other things, the problem of ghost fishing. In addition, data seem to indicate that the marine plastics pollution problem is particularly acute in the Pacific Northwest and Alaska. Thus NMFS seems to be a more logical choice. And, as stated earlier, the structure of the MMPA is compatible for instituting a net deposit-refund system.

On December 30, 1987 the President signed into law legislation designed to help combat the marine plastics problem. While the new law places some additional legal responsibilities on commercial fishermen, its major emphasis is on studying the problem with an eye toward recommending regulatory solutions within a specific time period.

Two parts of the law are of particular importance to the fishing industry. Title II provides implementing legislation for newly ratified Annex V of the MARPOL Convention (International Convention for the Prevention of Pollution from Ships). It prohibits the dumping of plastic materials into any ocean waters by U.S. registered vessels and into the U.S. EEZ by foreign vessels. To lessen the burden of disposing of shipboard garbage, the Act directs the Coast Guard to determine the numbers and types of waste reception facilities needed at ports to dispose of garbage accumulated aboard vessels. Regulations are then to be promulgated to ensure adequate facilities will be available for receiving shipboard garbage. Ports of terminals meeting the reception facilities requirement will be issued a certificate of compliance which is to be shown upon request of the vessel captain, agent, or other person in charge.

For enforcement purposes, the Coast Guard is authorized to inspect, at any time, vessels subject to Annex V to verify whether garbage has been disposed of in violation of the Act.

In addition to the dumping prohibition, Title II requires the Coast Guard to develop regulations requiring vessels to maintain refuse record books and shipboard management plans, and to display notices on board that inform crew members and passengers of the requirement of Annex V. The Coast Guard must promulgate these regulations within one year from the time that Annex V enters into force for the United States. Because it is unknown when sufficient nations will ratify Annex V for it to become legally binding on signatory nations, uncertainty exists regarding the effective date of such regulations.

In order to better understand the nature and scope of the marine plastics problem, the EPA, in conjunction with NOAA, is directed to conduct a study on the adverse effects of improper disposal of plastics into the environment and on the methods to reduce or eliminate such adverse effects. This study is to include (1) a listing of improper disposal practices, (2) a description of current legal authority to deal with the problem and steps being taken pursuant to such authority to reduce the amount of plastics entering the marine and aquatic environments, (3) the feasibility of using alternative materials as substitutes for non-degradable plastics, and (4) an evaluation of the impacts of plastics on the solid waste stream and methods to reduce those impacts, including the need for a plastic recycling program and the use of economic incentives to reduce plastic litter.

From the language of the legislation, it appears that EPA is responsible for the research of the overall problem and potential solutions, while NOAA is to direct its efforts and its final report to Congress to the effects of plastic materials on the marine environment.

Finally, Title II directs NOAA, EPA, and the Coast Guard to conduct a public education/outreach program about the plastics pollution problem and to encourage the formation of volunteer "Citizen Pollution Patrols" to assist in both prevention and cleanup efforts.

Title IV of the new law, designated the "Driftnet Impact, Monitoring, Assessment, and Control Act of 1987," is designed to deal specifically with the entanglement and ghost fishing problem associated with driftnet fisheries. "Driftnet" is defined in the Act as a "gillnet composed of a panel of plastic webbing one and one-half miles or more in length." The term "driftnet fishing" encompasses those fish harvesting methods "in which a driftnet is placed in water and allowed to drift with the currents and winds for the purpose of entangling fish in the webbing."

The purpose of Title IV is to gather more information regarding the incidental animal mortality problem associated with driftnet fishing so that Congress can develop a meaningful and realistic solution to this complex problem. It directs the Secretary of Commerce, NOAA's parent agency, to prepare, within one year, a comprehensive report to Congress on the nature, extent, and effects of driftnet

fishing in the North Pacific on U.S. marine resources. In addition, the Secretary is to evaluate and make recommendations regarding (1) the establishment of a driftnet marking, registry and identification system, (2) the feasibility of using alternative materials in driftnets that degrade faster in the marine environment, (3) the implementation of a driftnet bounty system for abandoned and discarded nets, and (4) the establishment of a cooperative driftnet fishing vessel tracking system.

This Title does not direct NOAA or EPA to promulgate regulations to reduce the incidental kill problem associated with the North Pacific driftnet fisheries, but rather asks for these agencies to develop data necessary for Congress to decide how best to approach the problem. Because this law contemplates further study before going forward on any particular solution(s) to the problem, it is unlikely that any federal agency will proceed under other statutory authority to address the problem until such time as these studies are complete.

B. State Law

In the absence of federal intervention, coastal states may choose individually to pass legislation mandating a net deposit-refund system. For many states, recycling bills are not a new concept. The so-called "Bottle Bills," requiring the exclusive use of returnable bottles and aluminum cans in certain parts of the beverage industry, have proven successful in reducing community litter and solid waste loads without the predicted drastic economic consequences. In addition, they have understood constitutional challenges based on Commerce Clause and equal protection grounds. Could a well-drafted net recycling system understand similar legal scrutiny? I believe so.

1. Commerce Clause

Under our system of government, states have the authority, indeed the duty, to protect the health and welfare of their citizens. Legislation thus enacted is said to be incident to a state's "police power." However, because of the Commerce Clause of the Constitution, states must yield to the federal government when the law would place an impermissible burden on interstate commerce [*Huron Portland Cement Co. v. Detroit*, 362 U.S. 440 (1960)]. Although there is no "bright line" defining when a state has overstepped its constitutional bounds, Court decisions indicate three levels

of inquiry. First, has federal action preempted regulation of the activity? Second, does the state action impede the free physical flow of commerce between and among states? And third, is the action really one of economic protectionism?

A review of the laws discussed above indicates that while Congress has entered the general fields of fisheries and marine pollution, it has not preempted all state authority. In fact, in the area of solid waste disposal, Congress has placed the major burden of dealing with the problem at the state level, with federal oversight and financial assistance. Absent Congress acting so comprehensively so as to "totally occupy the field," states are free to regulate [*Milwaukee v. Illinois*, 451 U.S. 304 (1981)]. So if the purpose of the state law is to reduce solid waste, it should pass a preemption analysis.

However, if the law is designed to protect marine mammals, a preemption problem may exist. The MMPA expressly prevents states from enforcing any state law or regulation relating to the taking of marine mammals within state waters without first being granted management authority over a species of marine mammal (16 U.S.C. 1379). Read broadly, this section could be used to find express preemption.

As to the impediment issue, courts generally require a showing of an actual impediment to the physical flow of commerce before striking down a law. This analysis has been used to uphold "Bottle Bills" under a Commerce Clause analysis [*American Can Co. v. Oregon Liquor Control Commission*, 517 P.2D 691 (Or.App. 1974)]. A net deposit-refund system on its face appears to pose no more burdens on the national distribution of nets than of cans or bottles under "Bottle Bills," i.e., there is no direct effect on the physical means of interstate transportation of nets.

If the purpose of the state net recycling legislation were to economically discriminate against out-of-state interests, it would present a serious constitutional problem. However, mere negative economic consequences on out-of-state businesses does not necessarily rise to the level of unconstitutionality. Proponents of the law would have to show that economic burdens caused by enforcement would be experienced by both in and out-of-state businesses [*American Can Co.*, supra].

2. Equal Protection

The Fourteenth Amendment of the U.S. Constitution prohibits the government from arbitrarily discriminating against actions of citizens and legally constituted businesses. The legal inquiry mandated by the courts is the existence of a legitimate governmental purpose and a rational relationship between the purpose and the provisions of the law. Environmental protection and reduction of solid waste are clearly legitimate exercises of a state's police power [see not only the legislation mentioned above, but also *Berman v. Parker*, 348 U.S. 26 (1954) and *Huron Cement Co.*, supra]. An experienced drafter should be able to construct net deposit-refund legislation reasonably calculated to achieve its objectives.

Although there are clearly potential constitutional problems associated with individual states adopting net recycling laws, such problems are not likely to be insurmountable if the statute is properly drafted.

CONCLUSION

Although our level of knowledge regarding the marine plastics pollution problem and its consequences is as yet imperfect, sufficient evidence exists to justify policy approaches are not immediately evident, but we must start now to improve our and legal responses. It is impossible to pass one law that comprehensively and effectively addresses the problem. And insistence on such an approach would likely lead to political inertia, exacerbating the ever-existent "tragedy of the commons." But implementation of programs such as the net deposit-refund system proposed at this workshop and other similar efforts will begin to reduce the amount of pollution and its senseless consequences. Both the federal and state governments have the legal means at their disposal to reduce the plastic waste entering the marine environment--what is needed now is a consensus translated into political will.

BIBLIOGRAPHY

1. *American Can Co. v. Oregon Liquor Control Commission*, 517 P.2d 691 (Or.App. 1974).
2. *Berman v. Parker*, 348 U.S. 26 (1954).

3. Code of Federal Regulations, Title 50 (1986).
4. Congressional Record -- House, H 11727 (Dec. 18, 1987).
5. Congressional Record -- Senate, S 18491 (Dec. 19, 1987).
6. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 26 U.S.T. 2403.
7. Endangered Species Act, 16 U.S.C. 1531 et seq.
8. Federal Water Pollution Control Act, 16 U.S.C. 1361 et seq.
9. Huron Portland Cement Co. v. Detroit, 362 U.S. 440 (1960).
10. K. Freeman, "We're Choking the Ocean With Plastics," *National Fisherman* (January 1987).
11. Magnuson Fishery Conservation and Management Act, 16 U.S.C. 1801 et seq.
12. Marine Mammal Protection Act, 16 U.S.C. 1361 et seq.
13. Marine Protection, Research, and Sanctuaries Act, 33 U.S.C. 1401 et seq.
14. *Milwaukee v. Illinois*, 451 U.S. 304 (1981).
15. Solid Waste Disposal Act, 42 U.S.C. 6901 et seq.
16. W.L. High, Some Consequences of Lost Fishing Gear, in *Proceedings of the Workshop on the Fate and Impact of Marine Debris*, R.S. Shomura and H.O. Yoshida, eds. (July 1985).

APPENDIX D

Remarks to the Oceans of Plastic Workshop Economic Evaluation of Incentives

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I. INTRODUCTION

My purpose this afternoon is to examine the use of *incentive systems* as a means of controlling the disposal of plastics in the ocean. I am not advocating incentive systems. While I believe incentive systems have their place, they, like any regulatory approach, also have limitations. In my opinion, the verdict is not yet in whether incentive systems should be used to mitigate plastic debris in the ocean.

Both advocates and opponents of incentive systems can benefit by understanding the arguments underlying this regulatory approach. Therefore, I would like to work with you today to do two things: first, to explain some of the advantages and disadvantages of incentive systems and other approaches; and second, through our subsequent discussion, to refine the arguments--both pro and con--regarding the use of incentive systems for addressing the problem of plastic debris in the ocean.

II. CATEGORIES OF POLICY APPROACHES

The evidence presented at this workshop demonstrates that the problem of plastic debris in the ocean is serious and some form of policy action is called for. The outstanding questions seem to be: What policy action? and Where should the policy action be directed? Since the fundamental source of the problem is people's behavior--to persuade or oblige people to dispose of plastics in a socially desirable manner. What are the policy obligations for achieving this end? I would like to examine four categories of policy approaches available to the public and private sectors: Moral Suasion, Direct Controls, Government Investment, and Incentive Systems.

Moral Suasion

Educational programs, publicity campaigns and social pressure can be employed to persuade individuals to obey proper norms of disposal. Posters such as the "Don't Teach Your Trash to Swim" and public clean-up efforts are examples of publicity and educational measures that make the general populace more aware of the plastic debris problem and help establish acceptable social norms for the application of social pressure. Perhaps the most well known program of this type is the Smokey the Bear campaign by the U.S. Forest Service.

Direct Controls

Policies of this type mandate or prohibit specific behaviors or the use of specific methods and/or equipment. Examples of direct control policies in fisheries include gear restrictions, closed areas and seasons and prohibited species. The policies set out in MARPOL Annex V are of this type.

Government Investment

Public projects to improve the environment are a form of government investment. Examples include municipal solid waste dumps and incinerators, sewage treatment plants, and fish hatcheries.

Incentive Systems

Financial inducements can be used to achieve socially desirable behavior. Examples of incentive systems in use include charges, subsidies, individual transferable quotas, and refundable deposits. Monetary charges levied on the quantity and quality of industrial effluents are used in Europe. Subsidies for the adoption of pollution abatement equipment and of energy-saving methods have been used in the United States. Individual transferable quotas, where the right to catch and sell a set amount of a specific species of fish, are being used in New Zealand as a means of controlling exploitation of fisheries resources. Refundable deposits on beverage containers are being used in Oregon and several other states, as well as on auto hulks in Sweden.

III. CRITERIA FOR SELECTING POLICY ACTIONS

How should we choose among these policy approaches? What policy or combination of policies is best? To answer these basic questions we need some criteria on which to base our choice. I propose we consider the following eight criteria for the problem at hand.

1. *Reliable effectiveness.* To what extent can we be sure that the goal of the policy will be achieved?
2. *Enforcement considerations.* Policies and their attendant regulations should be enforceable at reasonable cost relative to the benefits expected; and enforcing the regulations should not have socioeconomic implications that are unacceptable to society at large.
3. *Permanence.* The extent to which the policy is effective over the long term.
4. *Inducement to maximize desired behavior.* Whether the policy induces individuals to try to behave in the most socially desirable or just minimally acceptable manner.
5. *Economy.* The overall cost-effectiveness of the policy, where all direct and indirect costs are taken into account.
6. *Equity.* The perceived fairness to which the burden and the benefit of the policy are distributed among the community.
7. *Interference with individual decision making.* The objective here is to minimize the interference with individual decisions.
8. *Political attractiveness.* Policies must possess a minimum of political attractiveness for them to be adopted and implemented.

These criteria are not necessarily ideal. One shortcoming is that they are highly interdependent. For example, regulations that are unenforceable may be effective and impermanent, high enforcement costs may render a policy uneconomical, and

policies which are inequitable or interfere with individual decision-making may be unattractive politically. These criteria also are imperfect in that they are undoubtedly incomplete. I present them here regardless for I believe we need a point of reference on which to build our examination of policy options for the plastic debris problem.

IV. EVALUATION

I now turn to a preliminary evaluation of each category of policy approaches.

Moral Suasion

Pro: Efforts such as education and publicity campaigns will likely be politically attractive, be of low cost, involve little or no interference with individual decision-making, be perceived as equitable, and by themselves require no official enforcement action. **Con:** Education and publicity efforts are known to have only modest effectiveness and lack permanence.

Direct Control

Pro: Direct controls are usually perceived as being equitable since they are intended to apply equally to all citizens. Legal mandates and prohibitions are a popular form of policy and therefore must be considered generally politically attractive and feasible. **Con:** Many forms of direct control are unenforceable or, at best, very costly to enforce. The effectiveness and permanence of direct controls is often weak because enforcement is too costly and it is difficult to achieve a high degree of compliance. When enforcement is not effective, direct controls become inequitable as flagrant violators escape detection and sanctions. Direct controls clearly interfere with individual decision making. Studies show that direct controls impose significantly higher costs (direct and indirect) on industry than other regulatory methods. One study of U.S. industry showed that there was a \$20 cost burden placed on industry for every \$1 of government expenditures on regulations. The administration costs of direct control programs will likely be moderate to high. Mandates and prohibitions establish

minimum acceptable behavior and thus provide no inducements for firms and individuals to minimize the damage from plastic debris.

Government Investment

Public projects to mitigate the plastic debris problem are probably feasible only as shoreside disposal facilities (e.g., trash bins on the docks, dump sites and incinerators). Government investment in such facilities ranks high on all criteria, though private firms may be more cost-effective in providing shoreside disposal services.

Incentive Systems: Charges

A system of monetary charges to mitigate plastic debris may take two forms. One would involve, in effect, a tax on plastic products. By raising the cost of plastic, its use and improper disposal would be reduced. This approach only indirectly addresses the basic problem, that of improper disposal, and unnecessarily penalizes legitimate uses of plastic products. The other form would be a monetary charge on the disposal of plastic into the ocean. This second form of monetary charges directly addresses the disposal problem and is evaluated here. **Pro:** Charges provide inducement to minimize damages from plastic debris, they are expected to be more cost-effective than direct controls and only minimally interfere with private decision making. **Con:** Depending on the practical operational details of a charges program, enforcement may be difficult if not nearly impossible, except at high cost. If so, the effectiveness and permanence of the program would be weak. The administration costs of a charges program are likely to be moderate to high. The experience of other attempts in the environmental arena to levy charges suggest that this is a politically unattractive approach. Certainly, the industry faced with charges can be expected to lobby vigorously against a proposed policy of monetary charges.

Incentive Systems: Subsidies

Subsidies for the proper disposal of plastic debris may take the form of paying individuals a fee for bringing scrap plastic to a disposal site, or providing tax breaks for the installation of incinerators or trash compactors. **Pro:** Subsidies score well on five of the eight criteria. Save for the exception noted below, a sufficient high subsidy

can be expected to be an effective, long term means of inducing proper disposal. Subsidies offer good inducement for individuals to maximize the desired behavior, do not interfere with individuals' decision making and are more cost-effective than direct controls. There appear to be no serious equity considerations. **Con:** A subsidy program may be expensive and would require government financing. Like charges and direct controls, the administration costs of a subsidy program would likely be moderate to high. In these times of federal budget cuts, a costly subsidy program would not likely receive much political support. Subsidies for equipment may only induce installation of the equipment and not its use, and may induce more plastic disposal than otherwise (the exception on effectiveness). Attempting to subsidize only the fishing industry for the proper disposal of all plastic debris would likely encounter enforcement problems. For example, collectors of plastics discarded by non-fishermen would surely attempt to collect fees for scrap plastics. To be feasible, such a scrap-plastic fee program would have to apply to all sources of plastic debris, not just the fishing industry.

Incentive Systems: Transferable Disposal Permits (TDPs)

TDPs are probably infeasible and impractical, and do not warrant much discussion. Presumably, permits would be issued to individuals giving each the right to dispose of a given quantity of plastic debris in any way they choose. The total amount of permitted debris disposal would be set by a government authority. Holders of permits would be allowed to sell their permits to others, which in effect creates a price or cost on the disposal of plastics. **Pro:** If some way were found to effectively enforce and administer TDPs at modest cost, this type of program should score well on all other criteria. **Con:** The principal difficulty with TDPs in this case is that of enforcement. Effective monitoring of the disposal of plastics at sea is nearly impossible or, at the least, very costly. Also, the administration costs of TDPs would likely be high.

Incentive Systems: Refundable Deposits

Refundable deposit systems are basically combinations of the charge and subsidy approaches described above. As with those approaches, the basic idea is to provide a financial incentive to the user of plastic items to dispose of them properly. The system would require a deposit on all plastic gear and other items purchased by fishermen, with the deposit being refunded when the items are disposed of properly.

Such a system is described in more detail in the paper by Xan Augerot, presented earlier to this workshop. Refundable deposits have some of the same pros and cons of charges and subsidies but with notable exceptions.

Let's consider gear first. **Pro:** A refundable deposit on plastic gear is expected to be an effective and permanent means of reducing intentional disposal at sea. While it cannot be expected to reduce unintentional gear losses, a sufficiently high refund should induce finders of lost gear to return them to shore for proper disposal. A refundable deposit system is expected to be largely self-enforceable, to induce maximum desirable behavior, not to interfere in individual decision making and be more cost-effective than direct controls. A significant positive attribute is that a refundable deposit system can be self-financing, requiring no funds from the general treasury to operate the program. **Con:** A refundable deposit on plastic gear is expected to impose financial losses on fishermen. The losses would take at least two forms: tying up some of their financial resources in deposits, and forfeited deposits for lost gear. If the monetary value of the deposit is large, this approach could impose a considerable burden on some fishermen and, therefore, would be perceived as inequitable. The administration cost of this type of program is expected to be moderate to high, and there may be practical problems with its operation. It is not clear how politically attractive the program would be; the fishing industry will likely lobby against such a measure.

Next consider other plastic items such as food packaging materials. To be feasible, a refundable deposit on all other plastic items used on board fishing vessels would have to apply to society at large and not just to the fishing industry. Therefore, the general application of a refundable deposit on all or most plastic products is evaluated here. **Pro:** As with fishing gear, a refundable deposit on all plastics is expected to be reliable and permanently effective, be largely self-enforceable, to induce maximum desirable behavior and not interfere with individual decision making, to be more cost-effective than direct controls, and to be self-financing. In addition, because all users of plastic products are treated equally, there should be no serious equity problem with this program. **Con:** The administration costs of this program would likely be high and the program may encounter practical operational difficulties. The plastics industry may lobby vigorously against such a program and, therefore, this approach may not be politically attractive. In summary, the incentive system of refundable deposits scores high on five of the eight criteria, and on the

sixth criterion of economy out scores the other types of incentive systems and direct controls. The incentive system of subsidies also scores high on five of the eight criteria as well, but are not expected to offer a long term, effective solution to the problem of plastic debris in the ocean. Government investment approaches score high on all eight criteria, but have only limited applicability. The direct control option, often the most popular approach to problems of this type, has by far the lowest overall score.

Only subsidies and refundable deposit systems are expected to be reliability effective in the long-term. All approaches, with the possible exception of moral suasion, are expected to have moderate to high administration costs.

V. CONCLUDING REMARKS

This evaluation reveals an important fact: none of the policy approaches offers a perfect solution to the problem. Our choice must be made from among imperfect options.

Combinations of policies may indeed be the best approach to the problem. For example, moral suasion efforts combined with a modest subsidy program and government investment in on-shore disposal facilities may provide the highest scores on all eight criteria.

More consideration of alternative approaches to solving the plastic debris problem in the fishing industry is clearly required. Among other things, the fishing industry should be consulted to provide the data for evaluating the options in detail. The costs and practical problems of implementing an incentive system should have more definition than I have been able to provide here. The fishing industry is but one, and perhaps a secondary, contributor to plastics in the ocean. Municipal disposal of untreated sewage and at-sea disposal by the merchant shipping fleet and the world's navies appear to be the primary contributors. At the very least, the approach to the fishing industry should be coordinated with the policy approach to commercial shipping and other sources of plastic debris in the ocean.

VI. REFERENCES

Bohm, P. 1981. *Deposit-refund System: Theory and Applications to Environmental Conservation and Consumer Policy*. Baltimore: Johns Hopkins University Press.

Bohm describes some of the deposit-refund systems in use and provides an economic analysis of various versions of the systems.

Baumol, W. and W. Oates. 1979. *Economics, Environmental Policy, and the Quality of Life*. Englewood Cliffs, N.J.: Prentice-Hall, Inc.

The evaluation framework used above is a modification of Baumol and Oates' approach to general environmental policy design.

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