NOAA Technical Memorandum NMFS-AFSC-51

Poster Abstracts and Manuscripts from the Third international Conference on Marine Debris, May 8-13, 1994, Miami, Florida

by
J. C. Clary (editor)

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Fisheries Science Center

March 1995

NOAA Technical Memorandum NMFS

The National Marine Fisheries Service's Alaska Fisheries Science Center uses the NOAA Technical Memorandum series to issue informal scientific and technical publications when complete formal review and editorial processing are not appropriate or feasible. Documents within this series reflect sound professional work and may be referenced in the formal scientific and technical literature.

The NMFS-AFSC Technical Memorandum series of the Alaska Fisheries Science Center continues the NMFS-F/NWC series established in 1970 by the Northwest Fisheries Center. The new NMFS-NWFSC series will be used by the Northwest Fisheries Science Center.

This document should be cited as follows:

> Clary, J. C. (editor). 1995. Poster abstracts and manuscripts from the Third International Conference on Marine Debris, May 8-13, 1994, Miami, Florida. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-51, 108 p.

1A

NOAA Technical Memorandum NMFS-AFSC-51

Poster Abstracts and Manuscripts from the Third International Conference on Marine Debris, May 8-13,1994, Miami, Florida

by
J. C. Clary (editor)

Marine Entanglement Research Program
Alaska Fisheries Science Center
7600 Sand Point Way N.E., BIN C-15700
Seattle, WA 98115-0070

U.S. DEPARTMENT OF COMMERCE
Ronald H. Brown, Secretary
National Oceanic and Atmospheric Administration
D. James Baker, Under Secretary and Administrator
National Marine Fisheries Service
Rolland A. Schmitten, Assistant Administrator for Fisheries

March 1995

Notice to Users of this Document

This document is being made available in .PDF format for the convenience of users; however, the accuracy and correctness of the document can only be certified as was presented in the original hard copy format.

ACKNOWLEDGEMENTS

Special thanks to James M. Coe and Gary J Duker of the National Marine Fisheries Service's Alaska Fisheries Science Center for editorial review and technical assistance in preparation of this document.

CONTENTS

Page

Introduction 1

Conference Program. 3

Poster Abstracts 11

Session I Posters
Amounts, types and distribution of marine debris..... 13

Session II Posters
Impacts of marine debris..... 29

Session III Posters
Sources of marine debris: Vessels..... 39

Session IV Posters
Sources of marine debris: Recreational use..... 43

Session V Posters
Sources of marine debris: Coastal urban discharges..... 63

Session VI Posters
Sources of marine debris: Rural, coastal and upland discharges..... 69

Poster Manuscripts 75

Session I Poster Manuscripts
Amounts, types and distribution of marine debris..... 77

Session II Poster Manuscripts
Impacts of marine debris..... 85

Attendees List.....97

INTRODUCTION

During the early 1970s, increasing international concern over marine pollution from ships prompted the International Maritime Consultative Organization (IMCO, now known as the International Maritime Organization [IMO]) of the United Nations to address the issue. The International Convention for the Prevention of Pollution from Ships, 1973, was adopted by the International Conference on Marine Pollution, convened by IMCO, in November 1973. The Convention was subsequently modified by the Protocol of 1978 adopted by the International Conference on Tanker Safety and Pollution Prevention. The Convention, as modified by the 1978 Protocol, is known as MARPOL 73/78 and was designed to address the problem of marine pollution from ships on a global scale. MARPOL 73/78 consists of five annexes, each of which is directed toward a particular type of marine pollution.

Annex V, Regulations for the Prevention of Pollution by Garbage from Ships, prohibits at-sea disposal of plastic wastes and regulates the distance from land that all other waste materials may be discharged. Annex V also provides for Special Areas which, because of their unique oceanographic, ecological and/or traffic characteristics, are protected from all overboard discharge of garbage except comminuted food wastes, which can be discharged at distances greater than 12 nautical miles from nearest land. Annex V also requires that ports and terminals provide adequate reception facilities for ship-generated garbage.

In the United States, growing scientific concern over increasing marine mammal mortalities and injuries due to entanglements in lost and discarded synthetic commercial fishing gear prompted the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) to review the problem and convene a workshop to address the issue of persistent marine debris. The Workshop on the Fate and Impact of Marine Debris was held in November, 1984, in Honolulu, Hawaii. This Workshop was the first comprehensive effort ever undertaken to examine the impacts of marine debris on living marine resources. It was international in-scope, involved scientists, fishermen, government officials and conservationists, and concluded that a number of initiatives were needed, including the development of education, mitigation and research programs.

The 198.4 Workshop laid the foundation of information and recommendations that, until late 1988, had driven government, industry and private organizations to seek solutions to the problem. In conjunction with the United States' ratification of Annex V, and its subsequent entrance into force, the NMFS' Marine Entanglement Research Program (MERP) began planning a second conference to review the status of science, technology and administration relevant to the marine debris problem. The Second International Conference on Marine Debris (SICMD) convened in Honolulu in April 1989. Participants agreed that the marine

debris issue was a part of the larger solid waste management problem and that lessons learned from dealing with solid waste should be incorporated into marine debris education programs. The many recommendations arising from the SICMD included recognition of the marine debris problem as a symptom of the worldwide waste disposal crisis; expansion of marine debris and solid waste disposal education to people and institutions worldwide; development of a set of standard methods for marine debris surveys; and evaluation of economic impacts of marine debris.

Having identified and described the problem at the first two Conferences, in late 1992 the MERP began making plans for the Third International Conference. on Marine Debris (TICMD), with the focus on solution of the problem. Miami, Florida, was selected as the site because of its ease of accessibility. The Conference would synthesize all information relevant to the four main sources of marine debris and use that information and the expertise of the participants to develop practical framework plans for controlling marine debris worldwide& To achieve these goals, the Steering Committee organized the Conference into six, non-concurrent plenary sessions addressing the following topics:

1) Amounts, Types and Distribution of Marine Debris;
2) Impacts of Marine Debris;
3) Sources of Marine Debris: Vessels;
4) Sources of Marine Debris: Recreational Use;
5) Sources of Marine Debris: Coastal Urban Discharges; and
6) Sources of Marine Debris: Rural Coastal and Upland Discharges.

Each plenary session included a poster session and a Working Group to synthesize the information and produce Working Group reports and framework plans for controlling marine debris.

Because of the Conference's format, opportunities for presenting plenary papers were necessarily limited; The Steering Committee decided that organization and facilities should be such that large numbers of poster presentationscould be accommodated and that poster abstracts and manuscripts should be incorporated into a volume of the proceedings independent of the plenary papers.

The following poster abstracts and manuscripts are reproduced as presented at posters at the Conference (with minor editing) and do not reflect the policies or position of the NOAA/NMFS. They may be cited as follows:

> Author(s). Date. Title. In J.C. Clary (ed.), Poster abstracts and manuscripts from the Third International Conference on Marine Debris, May 8-13, 1994, Miami, Florida, p. x-x. U.S. Dep. Commer., NOM Tech. Memo. NMFS-AFSC-51.

PROGRAM FOR THE THIRD INTERNATIONAL CONFERENCE ON MARINE DEBRIS
Miami, Florida, May 8-13, 1994

Sunday, May 8

1500 - Registration

Monday, May 9

0830 - Welcome
James M. Coe, National Marine Fisheries Service, Conference Chair

0845-0915 - Keynote Address
Admiral J. William Kime, United States Coast Guard

0915 - SESSION I: AMOUNTS, TYPES AND DISTRIBUTION OF MARINE DEBRIS

0915-0930 - Introduction by
Mr. Anders Alm, World Bank

0930-1000 - P.S. Andersson
"State of Pollution by Marine Debris in the Caribbean"

1000-1030 - M.R. Gregory and P.G. Ryan
"Pelagic Plastics and Other Seaborne Persistent Synthetic Debris - A Review of Southern Hemisphere Perspectives"

1045-1115 - G. Rees and K. Pond
"Programmed Coastal Litter Surveys in Europe, With Particular Reference to the United Kingdom"

1115-1145 - A. Golik
"Litter in the Mediterranean Sea - Types, Quantities and Behavior"

1145-1215 - S. Matsumaura, K. Nasu and K. Hiramatsu
"Distribution of Floating Debris in the North Pacific from Sighting Surveys 1986-1991"

1330-1400 - P. Topping, A. Eade and P. Eaton
"Marine Plastic Debris Research in Canada"

1400-1430 -.C.A. Ribic, A. Cole, and S. Johnson
"Distribution, Abundance and Source of Plastic Debris on Coastal Beaches of the United States"

1430-1500 - R.J. Wilber, P.S. Joyce and G. Rollwagen
"Plastic in the Western North Atlantic Ocean Part I: Oceanic Distribution 1984-1991"

1515 - SESSION II: IMPACTS OF MARINE D E B R I S

1515-1530 - Introduction by
Dr. Charles W. Fowler, National Marine Mammal Laboratory

1530-1600 - K.E. McConnell, J. Kirkley and J. Sutinen
"An Economic Primer on Marine Debris"

1600-1630 - J. Sutinen
"A Socioeconomic Model of Controlling Marine Debris"

1630-1700 - D.W. Laist
"Entanglement of Marine Life in, Marine Debris"

1700-1900 - Working Group Meetings - Working Group I

Tuesday. May 10

0830 - Reconvene - SESSION II Cont'd.

0830-0900 - M. Robards
"The Highest Global Levels of Oceanic Plastic Debris and Their Increased Abundance in the North Pacific: Evidence from Seabirds"

0900-0930 - H.A. Carr and J. Harris
"Ghost Fishing Gear: Have Fishing Practices During the Past Few Years Reduced the Impact?"

0930-1000 - J.E. Winston, M.R. Gregory and L.M. Stevens
"Encrusters, Epibionts and Other Biota Associated with Pelagic Plastics - A Review of Biogeographical, Environmental and Conservation Issues"

1000-1030 - M.R. Gregory
"Plastic Micro-litter: An Underrated Contaminant Global Oceanic Waters"

1045 - SESSION III: SOURCES OF MARINE DEBRIS: VESSELS

1045-1100 - Introduction by
Mr. Dimitris Mitsatsos, Hellenic Marine Environment Protection Association

1100-1130 - P. Topping, D. Morantz and G. Lang
"Waste Disposal Practices of Fishing Vessels Off Canada's East Coast"

1130-1200 - R. Wade
"Environmental Challenges Faced by the International Cruise Industry: Harmony by Design and Operations"

1330-1400 - L. Koss
"Dealing With Ship-Generated Waste on Navy Vessels"

1400-1430 - J. Barnett
"Shipping and Marine Debris in the Wider Caribbean: Answering a Difficult Question"

1430-1500 - B.A. Wade
"Challenges of Ship-Generated Garbage in the Caribbean"

1500-1530 - D. Hollin and D. Shaw
"Comparison of Port Reception Facilities Utilization in U.S. Gulf of Mexico and United Kingdom for MARPOL Annex V Wastes"

1545-1615 - J. Miller
"Marine Debris Point Source Investigation: Padre Island National Seashore, Texas"

1615-1800 - Working Group Meetings - Working Groups II and III

1900-2200 - POSTER SESSION - Authors available

Wednesday, May 11

0815 - SESSION IV: SOURCES OF MARINE DEBRIS: RECREATIONAL USE

0815-0830 - Session IV: Introduction by Mr. John Brownlee, Saltwater Sportsman Magazine

0830-0900 - J. Ellis and M. Podlich
"Characterizations of Recreational Boaters/Fishers as a Source of Marine Debris"

0900:0930 - H. Viders
"Divers as a Source and Solution to Marine Debris"

0930-1000 - S. Laska
"Developing a Commitment to the Full Array of Marine Waste Reduction Opportunities: The Case of-Recreational Users"

1015-1045 - X. Zhang and V.K. Smith
"Measuring the Total Value of Marine Debris Control for Coastal Resources"

1045-1115 - D. -Rolleri, D. Martin, M. Silva, J. McCann, J. Glen and S. Bartholomew
"International Coastal Cleanup Program"

1115-1145 - J. Cathcart
"Mitigation of Marine Debris - Industry Efforts: Illinois Tool Works"

1145-1215 - J. Bowles
"Mitigation of Marine Debris - Industry Efforts: Berkley"

1330 - SESSION V: SOURCES OF MARINE DEBRIS: COASTAL URBAN DISCHARGES

1330-1345 - Introduction by
Mr. Paul J. Molinari
United States Environmental Protection Agency, Region II

1345-1415 - R.K. Kropp, H.K Trulli, W.R. Trulli and D.P. Redford "Comparison of Results of Two Environmental Protection Agency Marine Debris Studies"

1415-1445 - D.P. Redford and H.K. Trulli "Sources of Plastic Pellets in the Aquatic Environment"

1445-1515 - P. J. Molinari "Implementation and Assessment of a Floatables Action Plan for New York/New Jersey Harbor Complex"

1530-1600 - R.L. Swanson and M.L. Bortman "New York-New Jersey Beaches - It Was A Very Good Year"

1600-1630 - B. Flynn "Local Government Controls and Management Efforts for Coastal Marine Debris in Biscayne Bay, Florida"

1630-1700 - M. H. Randol and P.B. Brandt "Clean Streets/Clean Beaches"

1700-1830 - Working Group Meetings - Working Groups IV and V

Thursday, May 12

0830 - SESSION VI: SOURCES OF MARINE DEBRIS: RURAL COASTAL AND UPLAND DISCHARGES

0830-0845 - Introduction by
Mr. Usamah Dabbagh, World Bank

0845-0915 - R. Chaparro "Upland Sources of Marine Debris on the Shorelines of Puerto Rico

0915-0945 - G. Gold-Bouchot and O. Zapata-Perez
"Inland Sources of Coastal Debris and Solid Waste Management in Yucatan, Mexico"

0945-1015 - J.G. Singh
"Land-Based Sources of Marine Debris and Contamination of the Coastal Areas of the Caribbean Islands of St. Lucia, Dominica and the British Virgin Islands"

1030-1100 - A. Nollkaemper
"Legal Regulation of Upland Discharges of Marine Debris: From Local to Global Controls"

1100-1130 - E. Ninaber.
"The Interface Between Sea-Based and Land-Based Regulations: Beyond Port Reception Facilities"

1100-1130 - J. Sorensen
"Solid Waste and Coastal Management in Developing Nations"

1130-1200 - M. Liffmann
"Linkage Between Land-Based 'Sources of Pollution and Marine Debris"

1330-1530 - POSTER SESSION - Authors Available
1530 - Working Group Meetings - Working Group VI and others, if necessary

Friday, May 13

0815 - WRAP-UP SESSION:
WORKING GROUP REPORTS

0815-0830 - Introduction by
J.M. Coe

0830-0915 - Session I: Working Group Report and Discussion - C.A. Ribic

0915-1000 - Session II: Working Group Report and Discussion - P.G. Ryan

1015-1100 - Session III: Working Group Report and Discussion - B. Wallace

1100-1145 - Session IV: Working Group Report and Discussion - K. O'Hara

1300-1345 - Session V: Working Group Report and Discussion - R. Howard

1345-1430 - Session VI: Working Group Report and Discussion - M. Liffmann

1430-1530 - Conference Summary, Recommendations and Closing Remarks - J.M. Coe

1530 - Adjourn

POSTER ABSTRACTS

THIRD INTERNATIONAL CONFERENCE ON MARINE DEBRIS

May 8-13, 1994

Miami, Florida, USA

SESSION I POSTERS

Amounts, Types and Distribution of Marine Debris

Amos, Anthony F., Andrea Wickham, Charles Rowe, and Lynn Amos

An Evaluation of Volunteer Beach-Cleaning and Data-Recording Methods

University of Texas Marine Sciences Institute, Port Aransas, Texas, USA

The National Beach Cleanups, started in 1987 by the Center for Marine Conservation (CMC), have generated much public interest, and thousands of volunteers now participate in the twice-a-year event. Volunteers both clean beaches and record their findings on data sheets. The data are then compiled and published annually by CMC. There is no claim by the organizers that the results are statistically rigorous, but the number of "tons of trash" collected is widely reported in the media. A considerable database has now been amassed and, somewhat like the annual Audubon Christmas Bird Count, has its detractors and supporters as a means of assessing trends.

We have done several experiments in association with the Beach Cleanups. These include counts of marine debris on beaches immediately prior to, and then after, beach-cleaning by a group of volunteers. In particular, we made a complete examination of the contents of the bags of collected trash to compare our findings with the data recorded on the data sheets. To avoid bias, in each of the experiments the volunteers were not aware while collecting and recording that the results would be checked.

One hundred twenty-seven (127) bags of trash were collected by 53 volunteers on San Jose Island, Texas. The beach is inaccessible, by land and is not cleaned by any municipality. All bags were returned to the mainland by boat and thence to our facility. It took us a week to empty, classify, weigh and describe the 2,100 pounds of material collected (we worked in "English Units" to be compatible with the units used by CMC). Sand accounted for 192 pounds of the overall weight. Mean weight of a bag was 13.5 pounds with a standard deviation of 17.2. In general, volunteers under-counted by 50%. They were much closer on readily, identifiable items even though some of the items were quite small and numerous. For example, the counts were very close on one-gallon milk jugs, cigarette lighters, 6-pack yokes, straws, Styrofoam cups, light bulbs, food cans and paper cups. Big discrepancies were found in plastic bags, rope and, especially, beverage cans. Few errors were found in checking the totalling on the data sheets, but some important items were not entered accurately (e.g., total number of bags). We discuss the

difficulties associated with identification encountered by those unfamiliar with beach trash and errors associated with our own counts.

This result of only one such experiment does not necessarily extend to the volunteer counts in general nor is it meant to detract from the immense service done by the National Beach Cleanups and their volunteers. The use of trained volunteers is being considered in a nationwide effort to measure trends in beach debris and it is hoped this study will contribute to that effort.

Amos, Anthony F.

Marine Debris on a Texas Beach: Has MARPOL Made a Difference?

University of Texas Marine Sciences Institute, Port Aransas, Texas, USA

The quantity of marine debris on Texas Gulf beaches has long been a problem affecting several aspects of the beach environment: aesthetics, tourism, public health, local economies and marine animals. MARPOL Annex V, ratified by the U.S. in December 1987, prohibits the disposal at sea of plastics and restricts the disposal of other man-made debris. This regulation, and 'its enforcement, promised to reduce beach litter and improve the quality of the beach environment. This research sought to quantify and categorize marine debris on a Texas beach both before, and two years after, MARPOL Annex V went into effect. Various categories of debris were counted along a 11.8 kilometer (7.3 mile) stretch of Mustang Island Gulf beach, south of the city of Port Aransas. Counts were made at eight-day intervals from 1987 through 1989 and 1991 and 1992. Targeted item counts have been made bi-daily from 1987 through the present. Items too small to count were collected at three sites for one year in 1987/88 and 18 months in 1991/92. Dubbed "micro-trash," man-made items were classified and weighed, as were associated natural debris items. In an attempt to determine marine debris sources, all containers found in a 0.25 kilometer stretch of neighboring San Jose Island were collected monthly and classified by material, container size, content, country of origin, weight and volume..

Results show that many man-made items of marine debris have diminished in quantity on the study beach in the post-MARPOL era., These include plastic sheeting, cardboard cartons, light bulbs, milk jugs, egg cartons, glass bottles, Styrofoam pieces, 6-pack yokes, cups and lids and 5-gallon pails. Remaining steady, or increasing, were beverage cans, paper products, miscellaneous-plastic pieces and bleach bottles from Mexico. Circumstantially,

this might imply the early success of MARPOL Annex V, but the direct link was not established.

Baba, Norihisa and Masashi Kiyota

Distribution and Characteristics of Marine Debris in the North Pacific Ocean; 1989-1990

National Research Institute of Far Seas Fisheries, Fisheries Agency, Shizuoka, Japan

(Presented in the Manuscripts section.)

Boomsma, Joan J. I. and Randall W. Parkinson

Correlation Analysis Between Land-Based Activities and Land-Based Debris: A Preliminary Assessment

Florida Institute of Technology, Melbourne, Florida, USA

Successful marine debris reduction programs require guidelines that are able to distinguish between land-based and ocean-based debris. Improving the confidence in the accepted source indicator items, and increasing the knowledge of debris origin, requires some means of cross-referencing. Correlation analysis performed on land-based and ocean-based survey items and beach-goers provided support for the utilization of environmental parameters as an effective tool in distinguishing between land-based and ocean-based survey items.

This paper examined beach debris data from a pilot study conducted over a 14-month period. Five distinctive beach sites, with varying degrees of accessibility (e.g., boardwalks, parking), were sampled on a monthly basis. The number of beach-goers and meteorological and oceanographic conditions at the time of sampling were recorded. The beach debris was catalogued using the Center for Marine Conservation's (CMC) marine debris data card. By utilizing the pilot study data, the authors wanted to determine whether the EPA/NOAA-NMFS/NPS/USCG/CMC proposed land-based survey items would show positive correlations with the number of beach-goers. Further investigation was done to determine if there were any positive correlations observed between beach-goers and ocean-based debris.

The preliminary results indicated that of the nine land-based items, only metal beverage cans and straws were positively correlated with the number of beach-goers at two sites. There was no positive association observed between the number of beach-goers and ocean-based survey items,, except for fishing line at one site. Plastic bags with seams (less than 1 meter long),

though not part of the land-based category, showed positive correlation with beach-goers at one site. The Lori Wilson Park site, the most accessible and most often cleaned, showed that beach-goers had a significant correlation with metal beverage cans, straws and plastic bags with seams (< 1 meter).

Land-based items such as tampon applicators showed no significant correlation with beach-goers, but when seen geographically with respect to wind direction and speed, displayed seasonal trends. Fishing line, an ocean-based debris item, had a significant correlation with beach-goers at a site known for its surf fishing. Conducting correlation analysis on other land-based activities such as number of cars and one-quart motor oil bottles- could lend more support to using land-based activities as a source identification tool. Positive correlation coefficients might suggest that partitioning- survey indicator items before the initial correlation analysis may lead to erroneous results. The issue of remobilization ("trash-trading" terminology by CMC, 1994), where land-based debris of one country has been found on the shores of neighboring countries through meteorological and oceanographic factors, has recently come under close scrutiny. Dependent on the location of beaches, land-based sources were determined to be the main reason for beach debris. The question then remains, "How much of the beach debris is actually due to offshore vessels?"

In summary, the utilization of land-based activities for the identification of land-based and ocean-based debris seems a worth-while contribution in the establishment of successful marine debris monitoring programs.

Hall, Martin, Marco Garcia, Cleridy Lennert, and Pablo Arenas

Characterization of Floating Objects Associated with the Tuna Fisheries of the Eastern Pacific Ocean

Inter-American Tropical Tuna Commission, San Diego, California, U S A

The association of yellowfin tuna, Thunnus albacares, with floating objects ("logs") in the eastern Pacific Ocean (EPO) is a well-known fact, although the reasons for this relationship are not completely understood. In this work we attempt to characterize the floating objects encountered and the environmental conditions prevailing when they were sighted or set on during the tuna fishery.

Observers assigned to tuna purse-seine vessels as part of the Inter-American Tropical Tuna Commission's (IATTC) Tuna-Dolphin Program have gathered information on floating objects since 1987. They keep records of all floating objects observed, and, when a

set is made, information on the catch. The data recorded for each object include the date, position, and time of day, environmental conditions (sea-surface temperature, cloud cover, water clarity, wind speed and current strength), characteristics of the object (size, longest dimension, area and volume, shape, color, type, material, position in the water, estimated time adrift, coverage by epibiota and percentage submerged). In the case of parts of trees, the most abundant type of floating object, additional information is recorded on whether they were cut and whether roots, branches, bark, and leaves were present; this helps to define the spatial structure created around the tree part and to estimate its "age" in the water. In this study, we analyze a total of 5,498 records of floating objects, collected during 497 fishing trips made in the period between 1987 and 1991.

The most significant group was plant material (47.8% of all floating objects), followed by wooden man-made objects (17.5%); discarded equipment (12.7%); Fish Aggregating Devices or FADs (7.6%) and non-wooden man-made objects (5.8%). The rest included kelp, dead animals, unidentified and other objects (8.6%). Wooden and other biological materials comprised 72.6% of the objects, while 19.7% were made of non-biological materials. The origin of over half (57.9%) of the floating objects were man-made or due to human activities and 42.1% were of natural origin. Considering the epibiotic coverage and general aspect, the estimated time adrift of the objects was approximately evenly distributed (28.5% short, 6.3% medium and 35.2% long).

The spatial distribution of floating objects showed the highest concentrations in coastal areas, up to 100°W longitude and between 0° and l0°N latitude, especially in the Panama Bight. A "high-density corridor" along the l0° latitude north seems to be evident. It's important to note, however, that this spatial distribution may be biased by the tuna fishing fleet's own distribution.

Jozwiak, Tomasz

Amount, Types and Distribution of Marine Debris on the Polish Coast (Europe) in 1992 and 1993

Sopot Ecological Institute, Sopot, Poland

A qualitative and quantitative description of the marine debris on the Polish coast and ascertaining the influence of weather conditions on the recreational source of litter has been recognized. The amount and distribution of marine debris on 55% of the total Polish coast in a 2-year period (1992 and 1993) was investigated. The Polish coast was divided into 500 m units. Data from every recognized unit have been collected in a single

questionnaire. Five km blocks consisting of 10 units have been used for the analyses. The investigations were organized in a period of two weeks after, the recreational season (September 15-30). The data were collected by groups of trained students from coastal schools.

All types of marine debris on the coast-have been thoroughly investigated: landfill materials (e.g. concentrate, rubble), large metal objects (abandoned vehicles, girders), household furnishings, household refuse in bags or piles of rubbish', ship wreckage, dumped crops, tires, lost or discarded plastic fishing gear, packing. straps, beer can holders, plastics, foamed polystyrene and polyurethane, tar, oil, gas, containers of potentially hazardous substances, textiles and items of clothing, paper, cardboard, all wood, vegetable waste, food, fish waste and bones, feces, sanitary materials, medical waste, glass and cans. Two methods of describing the presence of marine debris on the coast were used. The typical recreational litter (drink containers) were counted. Occurrence of non-recreational debris for each 500 m unit was observed.

As a result of the investigations, the littering of the Polish coast and the main sources of marine debris in years 1992 and 1993 were determined. The most littered areas of the Polish coast are the east and central-west-parts. In 1993 a general increase in littering has been observed., The recreational abuses were the main source of marine debris in Poland. In 199-3, the average number of all types of drink containers was 234 pieces on a 5 km distance, which means an increase in comparison with the 1992 results (210 pieces). In 1992, 27% of the investigated coast has been described as grossly or moderately littered. In 1993, the same description was given to 67% of the recognized. coast. No influence of the weather has been detected. The accumulation of marine 'debris-on the Polish coast is observed. The industrial source is insignificant in this process.

This research is a part of the European-wide project "Coastwatch Europe" which is under the auspices of the European Parliament in Brussels (DGXI).

Moehl, Richard L., Stephen D. Wise, Dean S. Wise, and John B. Edwards.

Beach Sweep '93, St. Helena Island, Northern Lake Michigan

Great Lakes' Lighthouse Keepers, Association, Allen Park, Michigan, USA

During June 1993, a systematic beach clean-up of St. Helena Island was undertaken. St. Helena is a 91 hectare, kidney shaped island with a 5 kilometer-perimeter that lies at the western end

of the Mackinac Straits in northern Lake Michigan. It is about 9.6 kilometers west of the Mackinac Bridge, 3.2 kilometers off the coast of Michigan's upper peninsula, and approximately 0.8 kilometer north of the Lake Michigan-Lake Huron shipping lanes. The island has been essentially uninhabited since the early 1920's. The shallow water and limestone reefs that surround most of the island, together with unpredictable and sometimes severe weather and lake conditions have, in general, limited access to the island.

The clean-up of the beach on this inland was considered of interest since: (1) this clean-up is believed to be the first on this privately owned island,' and (2) the close proximity of the island to the Lake Michigan-Lake Huron shipping lanes. It was theorized that the items found on the beach would reflect water-borne debris deposited, over many decades from both remote shore dumping and ship litter.

For the collection, the beach zone was divided into 100 meter sections and three-person crews collected, sorted and recorded the nature of the debris. A data sheet supplied by the Inland Seas Educational Association of Suttons Bay, Michigan was used to count and classify the items. Only items roughly the size of a soft-drink can or larger were classified. Approximately 350 items/kilometer were collected from the beach zone; Some items that had been on the beach for many years had disintegrated into small pieces or did so when handled. It is estimated that if these items were included in the clean-up that approximately 750 - 1,000 items/kilometer would have been collected. The distribution of collected items was 46% plastic, 16% glass, 13% metal, 11% Styrofoam, 8% paper, 3% wood, 2% rubber, and 1% cloth.

Borne by the prevailing current of Lake Michigan into Lake Huron, the variety of items collected included: syringes and test tubes, most likely from a recorded illegal dumping of medical waste in Lake Michigan near Holland, Michigan, in 1989; a Michigan Department of Natural Resources sign from either Wagauschance Point or North Manitou Island warning visitors not to enter a Piping Plover nesting area; the top of a telephone pole; balloons; plastic containers; Styrofoam; and, a freon recharging container. Many of the metal cans and drums were heavily rusted and disintegrated from exposure including one bucket with a 15 centimeter tree growing through the middle of it.

Evidence of ship littering included: fish net remnants; floats; numerous unbroken light bulbs; a large cabled industrial tire that probably served as a fender on a barge or freighter; and, soft-drink cans printed in Dutch and Japanese. Two items gave indication that some of the debris was deposited from a counter current in the Straits. One was a bottle containing a note dated October, 4, 1974, and the second was a wooden traffic control

sign. Both entered the water directly beneath the Mackinac Bridge located almost 10 kilometers downstream from the island.

Considerably more debris was found on the island's southwestern shore, which faces the expanse of Lake Michigan, than on the sheltered northeastern shore. The southwestern-shore debris was more characteristic of items from passing boats and freighters, while that in the sheltered harbor on the northeastern shore was what might be expected from pleasure boaters and day visitors to the island.

Also apparent from this study were the effects that variations in lake levels and storm surges have on the deposition of debris n the island. Periods of high lake levels have both a cleansing. effect on the beach, refloating debris that was previously deposited and returning it to the lake, and also the effect of pushing the debris up and over the beach's berm and depositing it fifteen or more meters inland where the dense vegetation has retained it.. This latter effect was most apparent on the southwestern shore of the island where much of the debris was found above the berm.

Future efforts at St. Helena will focus on debris that has been carried over the berm and is now trapped by the dense vegetation. It is believed this area will contain many additional items that may be correlated with high water level years of the past century. The authors would like to acknowledge the members of Boy Scout Troop 4, Ann Arbor, MI who assisted in this cleanup.

Ribic, Christine

Power Analysis for a National Beach Survey

Department of the Interior, National Biological Survey, Madison, Wisconsin, USA

Because of the complexity of the problem, the power analysis for the beach survey design cannot be done in the familiar univariate framework where there are simple equations involving a single estimate of variability that are solved to calculate power and sample size. Instead, a more complicated approach incorporating the correlations between observations taken over time will have to be used. Because of the complexity; a limited number of sample sizes will be considered and specific alpha values used. I will be considering alpha of 0.05 and 0.10 and will be looking for scenarios where the power is 0.80 or greater. Specific sampling periodicities of yearly,, quarterly and monthly will be considered. Nine regions and sample sizes of 5, 10 and 20 per region will be used. In practice, the exact number of survey units will have to be adjusted upwards by the probability of losing a unit (by region). The question to be addressed will be,

"What sample size and sampling frequency are necessary to detect a decrease of 20% in debris over five years?,,

The approach follows the outline of power analysis presented in Muller et al. (1992). The multivariate linear model upon which this analysis is based is a repeated measures model with one within subject factor, time, that occurs at p time points (i.e., p-5 for annual surveys). Assumptions made are homogeneity of variance (i.e., the error structure is the same between survey units and, hence, between regions), independent survey units, and that the debris on beaches can be modelled using a multivariate normal distribution.

The null hypothesis is defined by: $H,: 0 = 0_o$ (axb)

where 0-CBU.B is the matrix of regional effects over time. Each row of C defines a contrast among regions; it has dimension axq (where a is the number of contrasts and q is the number of regions). Each column of U defines a contrast among the time periods; it has dimension pxb (where b is the number of contrasts and p is the number of time points). Following Muller et al. (1992) we will use the Pillai-Bartlett trace statistic (PB) because of its robustness to violations of the ANOVA assumptions, specifically, normality and constant variance. The distribution of this test statistic when the null hypothesis is true can be approximated by a central F-distribution. When the alternative hypothesis is true, the test statistic has approximately a non-central F-distribution. The non-centralist parameter w (of the non-central distribution) can be defined by the value of the test statistic when the alternative is true.

Let $Pr[F'(w)>F_{orit}(ab,df_2(PB),]$ be the probability, based on a non-central F-distribution with ab and df_2(PB) degrees of freedom and non-centrality w_1 of being less than F_{orit}. F_{orit} is the critical value from the central F-distribution (i.e., under the null hypothesis being true) using a specified alpha (i.e., 0.05 or 0.10) and df_1=ab and df_2=s[(N-r)-b+s]. Then power is approximately $1-Pr[F'(w)>F_{orit}(ab,df_2(PB),]$.

In order to do a power analysis, we need to turn the question into a null hypothesis- and decide on the contrast weights. We are interested in whether or not the trend in each region is decreasing by the stated percentage. In other words, are the slopes of the lines for each region parallel and of a specific value? We will be using linear orthogonal contrast weights. We will set up the null hypothesis so that rejecting it means that the decrease must be at least 20%. For annual surveys, this translates to be H,:. The weighted average number of pieces of debris at the last two time points is greater, than or equal to 80% of the weighted average number of pieces of debris at the

first two time points for each region. Power was calculated for the different sampling frequencies and number of survey units and tabulated.

Ribic, Christine, Heidi Lovett and Ginnie Gottshall

A Pilot Project for Detecting Trends in Marine Debris Along the East Coast of the United States

Department of-the Interior, National Biological Survey, Madison, Wisconsin, USA

The USEPA Office of Water has decided to implement pilotstudies to detect changes in trends of litter in the aquatic environment due to the implementation of legislation. The ideal question to answer is, "Has the legislation reduced the amount of floating litter in U.S. waters?" This question is probably not answerable directly due to the problems of sampling in the aquatic, environment. Therefore, the question was reformulated as, "What is the trend in aquatic floating litter as reflected by the trend in the amount of litter that is on the nation's lands adjacent to waters of interest?,,

The approach used, here is to use indicator survey units, defined as land areas adjacent to surface waters of interest that have large amounts of litter on them, and sample these units over. time.' For water quality trend surveys, one general approach is to establish a few survey units and intensively sample the units uniformly over time. The actual number of survey units is usually dictated by economic considerations.

In this program, the suggested survey periodicity was once a month for five years. Sites in New Jersey and Maryland were considered. The Center for Marine Conservation (CMC) picked one survey unit in New Jersey and one in Maryland and conducted surveys approximately every 28 days (range 27-30 days for New Jersey). The New Jersey survey site successfully completed a year and a half of surveys. The Maryland site, during the first survey year, was impacted by severe winter storms that washed the beach away. The site was also used by nesting seabirds. This resulted in noncomparability of data (due to the major changes in beach structure) and missing data (due to the nesting birds). The analysis presented here is an example of the types of analyses that can be done with the data.

The data were rewritten into CMC general categories. We considered total debris and total debris by source (ocean, land, unknown). Ocean-source waste was divided into galley, operations and commercial wastes categories. Land-source waste was divided into sewage and medical wastes. Each survey was assigned to a season (spring, summer, autumn or winter) using the usual

demarcations for the seasons (March 21, June 21, September 21 and December 21).

An average of 405 pieces of debris (s.d.=178) were found on the survey units; an average of 18 pieces (s.d.=ll) were ocean-source, 9 pieces (s.d.=8) were land-based and 378 pieces were unknown-source (s.d.=171). The unknown-source debris predominated in all surveys. In addition, there is a strong linear relationship between the amount of unknown-source debris and total debris, not seen with the other debris sources. Pearson correlations were 0.998 for unknown-source versus total debris, 0.284 for land-source versus total debris and 0.507 for ocean-source versus total debris.
Seasonally, there was little difference in total debris, with means ranging from a low of 386 pieces of debris in the summer to a high of 421 pieces in the autumn. The high amount of variability in the counts within a season resulted in an overlap of the distributions between the seasons.

Ocean-source debris was found consistently on every survey. The means ranged from a low of 12 pieces in the summer (s.d.=6) to 24 pieces in the spring (s.d.=14). The seasonal variability was high with winter having more extreme observations than the other seasons. Total ocean waste was divided into three source categories: galley, operations and commercial wastes. Commercial wastes followed the total ocean source pattern more closely than galley and operational wastes.

Land-source debris was found consistently on every survey at relatively low levels. The means ranged from a low of 4 pieces in the summer (s.d.=3) to 14 pieces in the autumn (s.d.=l0). The seasonal variability was high with the most variability found in the spring and autumn. Total land waste was divided into two source categories: sewage and medical wastes. Sewage waste followed the total land-source pattern more closely than medical waste. Medical waste was found sporadically throughout the surveys with no discernable pattern.

Sabourenkov, Eugene

The Distribution and Types of Beached Marine Debris in the Antarctic

Convention for the Conservation of the Antarctic Marine Living Resources (CCAMLR), Hobart, Tasmania, Australia

Over the last several years CCAMLR has adopted and implemented a set of steps to monitor and evaluate the impact of anthropogenic debris and waste on marine living resources in the Convention Area including periodical survey of beaches and seal and penguin colonies near coastal stations for marine debris. Marine debris

surveys, in the context of CCAMLR, are aimed at monitoring the incidence of marine debris and its impact on marine living resources in the Convention Area. In particular, beach surveys should yield information to determine how effectively measures related to the prevention of pollution of Antarctic waters adopted by CCAMLR, the Antarctic Treaty (Annex IV to the Protocol on Environmental Protection), MARPOL 73/78 (Annex V) and London (Dumping) Convention, 1972, have been implemented.

The first results of marine debris surveys in the Convention Area and adjacent waters were reported to CCAMLR in 1988 although some surveys were conducted by CCAMLR members as early as in 1984. The length of sampling units have varied considerably between surveys but recent surveys tend to use sampling units of about 500 to 1000 m. From 8 to 104 items were generally found per 1 km of the sampling unit (all debris items combined). The debris items have been typically classified according to what the items are made from, their size and the manufacturer's intended use. Major categories of beached marine debris found in the Antarctic waters are wood and plastic. In general, an amount of beached marine debris found in the Antarctic is small in comparison with other parts of the World Ocean. However, some persistent plastic objects, such as strapping bands and small plastic fragments, represent a threat to marine mammals and birds.

A comparison of survey methodologies used by CCAMLR members has indicated a lack of standardization in the timing, duration and frequency of surveys, length and-width of the selected surveyed units (beaches), classification of objects and presentation of data. Although surveys are generally aimed at monitoring the accumulation of marine debris by type and its change over time, the sampling effort and the amount of data collected do not justify the planning of assessment studies which require statistically planned survey designs. Therefore, it was proposed that current studies should be designed as baseline studies and continued until a baseline required for planning of assessment studies, is established. It was also proposed that the planning of surveys should meet certain minimum data requirements in order to collect statistically comparable data and to establish a baseline for conducting future assessment studies.

The Standard Method for Surveys of Beached Marine Debris was drafted- and adopted by CCAMLR in 1993. The Method establishes a set of standard requirements for conducting surveys while allowing members to do more intensive work if felt necessary. In particular, more intensive work is required because the number of sites being surveyed is few and wide spaced and some of the areas with active fisheries have no survey for debris being undertaken.

Tsubata, Hideki and Masahiro Morita

Global Environment Monitoring With Use of Fishing Vessel Network

Conservation Division, Fisheries Agency, Tokyo, Japan

The Japanese Fisheries Agency has decided to launch a new project to monitor the worldwide contamination of the ocean by the persistent and toxic chemicals, over the five-year period from 1992 to 1996. This project was planned to make use of the commercial fishing boats and research vessels of the Japanese Fisheries Agency, which worked together mainly for the collection of samples.

Survey Items and Method: The contaminants monitored in the present survey involve plastic particles, oil and bioaccumulative toxic organochlorines such as PCBs, HCHs, DDTs, CHLs and HCB. At the same time, the water temperature was monitored both horizontally and vertically during the cruise route of vessels. Plastic resin, oil balls and other substances were sampled with a well-designed neuston net. For air and sea water sampling, a semi-automatic apparatus which consists of absorbents was developed. Each apparatus was designed for easy use by fishermen. The samples and data will be collected from the international waters over the world.

Overall Analyses of the Survey Data: The maps of the present status of sea water contamination caused by plastic particles, oil, organic chloride compounds and other substances were drawn, and the processes of these contamination were examined.

Release of the Results: The results obtained by the project shall be released to the public, which includes the reporting to the international organizations concerned to draw worldwide attention to the importance of protecting the oceanic environment.

Van Veen, Allard and Valerie Thorn

Designing and Conducting a Research Program, Utilizing Volunteers, to Determine Sources of Marine Debris

Pitch-In Canada, White Rock, British Columbia, Canada

PITCH-IN CANADA, a non-profit private organization, has been concerned about, and involved in, marine debris since its formation in Victoria, B.C., Canada in 1967. As a founding member of Clean World International, an international waste management Secretariat, it has been a leading advocate of encouraging countries to adopt internationally recognized

research standards in order to identify and address the sources of marine debris.

In 1991, PITCH-IN CANADA, supported by Environment Canada, the plastics industry and the British Columbia Ministry of Environment, Lands and Parks, successfully conducted preliminary research at 51 sites on the West Coast of Canada to test the applicability of an international research model, as designed by Mr. Trevor Dixon of the United Kingdom.

In 1992/93 PITCH-IN CANADA, with support from Environment Canada, extended their preliminary research to Atlantic Canada in order to ensure that, once implemented, the proposed international research model would be applicable to conditions in Atlantic Canada. As a result of this initial research, the international methodology was modified to meet Canadian conditions.

In 1994 PITCH-IN CANADA has been contracted by Environment Canada to develop a Volunteer Training Manual as well as data software to enable implementation of Canada's National Marine Debris Surveillance Program. This Program is currently scheduled to be introduced, to both Coasts of Canada, in 1995 in a cooperative effort between Environment Canada, PITCH-IN CANADA and an extensive network of volunteers.

Wace, Nigel

Ocean Litter Stranded on Australian Coasts

Australian National University, Canberra, Australia

Australia receives flotsam and jetsam from large areas of the Southern Hemisphere oceans, with poleward-flowing currents along both west and east coasts delivering drift from the tropical Pacific, and the Antarctic Circumpolar Current feeding marine litter from Atlantic and Indian Oceans to the south coast of the continent. Half the Australian coastline consists of sandy beaches, much of it with an arid hinterland. Geomorphic, ecological and socio-economic factors make the continental coastline suitable for monitoring ocean litter in the Southern Hemisphere.

Attempts to establish annual baselines for the quantities and types of marine debris arriving on some remote southern Australian beaches are described. Yields from beach cleanups (e.g., "Adopt-a-Beach,', "Clean-up Australia,,), although socially and environmentally useful, are of little use in ocean monitoring because land-based litter is mixed with marine debris on popular beaches. Australian beach litter of marine origin consists of. some 60% plastic and 30% glass (by weight), with 7-15 kg and up to 400 items per kilometer of litter stranded per year, but the rate of litter burial, dispersal and destruction on beaches is

little understood. Most stranded marine debris is from nearby fisheries, with small inputs from more distant sources. Research priorities in establishing baselines for quantities and types of marine debris on Australian coasts are:

1) Development of standard accounting methods for classifying and measuring quantities of beach litter, so that yields from different places in Australia and overseas can be compared.
2) Regular and systematic collection of ocean litter at selected beaches in different parts of the continent remote from human land-based activities, and publication of audited yields of this monitoring.
3) Experimental work on the dynamics of stranded marine litter within sediment flux and energy dissipation in coastal geomorphic systems.
4) Offshore neuston trawling linked to beach surveys, and analyses of encrusting biota growing on floating and stranded litter.

Wade, Barry A., Bevon V. Morrison and Margaret A.J. Jones

Investigation of Beach Litter in Jamaica

Environmental Solutions, Ltd., Kingston, Jamaica

A study of litter on Jamaican beaches was conducted between June and September 1988 in order to determine the nature and extent of the litter on beaches and its sources. Collection involved three circuits of the island with- data taken from fifty beaches. Results indicate that plastics are the most abundant type of material (by weight and by number) and that litter is concentrated in three main areas of the island (the north coast, the east coast and Kingston and its environs). Most of the litter found on Jamaican beaches is from local sources, although there are some foreign influences (mainly on the east coast).

The litter studied was divided into three categories based on identifiable uses - marine, recreational, and household. The poster display will include pie charts, island bar graph and photographs.

Weikart, Heather

Summary of Marine Debris Observed from U.S. Fishing Vessels in the Northeast Pacific Ocean and Bering Sea; 1992-1993

National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, Washington, USA

Historically, there have been two sampling methods used to assess the abundance of marine debris: open-water surveys and beach surveys. Beach surveys have proved to be the most cost effective, but recently there have been a number of attempts-to estimate the amount of debris in open water. Fisheries observers are in a unique position to collect information concerning the types and distribution of marine debris. As a result of a 1991 agreement between the Marine Entanglement Research Program and the NMFS Alaska Fisheries Science Center Groundfish Observer Program, a marine debris data collection project was developed to quantify the amount of debris generated from vessels participating in the groundfish fisheries of the Bering Sea and the Gulf of Alaska, retrieved with the gear, or observed on the water surface. Since observers began collecting data in 1992 they have recorded over 3,300 pieces of marine debris retrieved by commercial fishing vessels. The majority of this debris was associated with fishing operations; net fragments, longline gear, crab pots, etc. However, it also includes plastics, tires, hulls of boats, and a rocking horse. In addition to recording the retrieval of marine debris observers have also completed 636 sighting surveys for debris. They have accumulated over 700 hours of survey time and have recorded 64 positive sightings of debris. Although a wide variety of items have been sighted, the most common has been paper and lumber.

SESSION II POSTERS

Impacts of Marine Debris

Baba, Norihisa

Characteristics of Northern Fur Seals Callorhinus ursinus Entangled in Marine Debris in the Western North Pacific and in the Okhotsk Sea from 1971 to 1987 and 1993

National Research Institute of Far Seas Fisheries, Fisheries Agency, Shizuoka, Japan

(Presented in the Manuscripts section.)

Bjorndal, Karen A. and Alan B. Bolten

Effects of Marine Debris on Sea Turtles

University of Florida, Gainesville, Florida, USA

Our studies of the interactions of sea turtles and persistent marine debris began in 1989 and have been funded by the NMFS Marine Entanglement Research Program. We have taken three approaches: evaluation of interaction of pelagic-stage loggerheads (Caretta caretta) and marine debris in the eastern Atlantic; establishment of a network of observers on vessels to report at-sea observations of sea turtles; and quantification of debris interactions with sea turtles stranded along the Florida coast.

Our work with pelagic-stage loggerheads in the eastern Atlantic is based on the theory that the earliest developmental habitats of sea turtle hatchlings, once they leave the nesting beach, are oceanic convergence zones. These convergence zones provide both physical refuge and food resource to the turtles. However, because the physical factors responsible 'for establishing these convergence zone communities also concentrate marine debris, turtles inhabiting convergence zones have high exposure levels to marine debris.

We have been studying a pelagic loggerhead population in the Azores Archipelago in close collaboration with the Department of Oceanography and Fisheries, University of the Azores, Horta. These loggerheads are believed to be derived from the southeastern U.S. breeding population. We have established a cooperative program with the tuna fleet in the Azores. While crews of tuna vessels search the ocean surface for evidence of tuna, they see loggerheads and can easily capture them in dipnets. The fishermen tag and measure each turtle and note any

debris entanglement; Over 800 turtles have been captured in this manner.

We have attempted to answer two questions. First, what is the extent of entanglement in, and ingestion of, marine debris by sea turtles in the pelagic habitat? Based on data from the tuna fishermen, over 6% of loggerheads in the pelagic habitat around the Azores are entangled in debris. This percentage is an underestimate of the turtles affected, because entangled turtles would be quickly removed from view by predators and scavengers. Data on ingestion of marine debris are more difficult to acquire, but we have inspected the digestive tracts of eight loggerheads from the Azores and found Styrofoam, other plastics, and star throughout the length of each tract.

The second question is how many years do turtles remain in the pelagic habitat, exposed to high levels of marine, debris? Two lines of evidence--growth rates of recaptured tagged turtles-and length-frequency analysis of carapace length data from the tuna fishermen--both indicate that the average duration of the pelagic stage for Atlantic loggerheads is from 10 to 12 years. This time' period is much longer than earlier "guesses", that had been incorporated in demographic models; the revised estimate is-an important advance in our understanding of the life history of this species.

We have established a network of more than 900 observers on research vessels and private yachts throughout the world. We provide observers with forms (in English, Spanish or Portuguese) to record size and location of turtles and any interactions with marine debris. Identification of species, which is often difficult, is of secondary importance. This network yields information on entanglement of turtles in debris, not ingestion of debris, because these records are limited to external observations. More than 1500 observations of sea turtles have been reported; approximately 5% of the observed sea turtles were negatively affected by marine debris.

We examined 51 sea turtle carcasses that stranded on the coast of Florida. Of those, 6% had been entangled in debris. Debris was found in 24 of 43 green turtles (Chelonia mydas), 0 of 7 Kemp's ridleys (Lenidochelys kemni), and 1 of 1 loggerhead. Ingested debris included plastic, monofilament line, fish hooks, rubber, aluminum foil and tar. Ingestion of debris by green turtles was not significantly affected by location of stranding, season or body size, but females had a significantly higher frequency of occurrence of debris than did males (chi-square, $P < 0.01$). Ingestion of small quantities of debris can kill sea turtles. In two green turtles that had clearly died as a result of debris ingestion, the debris weighed only 2.2 and 6.5 g and had a volume of 3.0 and 4.5 ml.

Cliff, Geremy, Sheldon Dudley and Peter G. Ryan

Large Sharks and Plastic Debris in Natal, South Africa

Fitzpatrick Institute, University of Cape Town, Rondebosch, South Africa

Approximately 1,440 large sharks, comprising 14 species, are caught annually in the nets which protect users of the tourist beaches of Natal against shark attack. Between 1978 and 1993, 13,371 of these sharks (60% of the catch) were examined in the laboratory. The presence of plastic either in the stomach or entangled around the shark's body was recorded. Fishing line was excluded.

Of the 12,737 sharks with recorded stomach contents, 51 (0.40%) had ingested plastic items. The most common items were packets or sheets, which were found in 32 stomachs; four of these were labelled as bait packets and two contained meat remains. Other items included nylon rope (three stomachs), vegetable sacks (two stomachs), 250 ml drink containers (two, in one stomach), a gum boot (one stomach) and an ice cream container (one stomach). All the sharks appeared to be healthy and unaffected by these items.

Of the 411 tiger sharks Galeocerdo cuvier examined, 8.3% had ingested plastics. The frequency of occurrence of plastics in the stomachs of each of seven other species was less than 1% and no plastics were found in 'six species. There was no evidence of any increase in the ingestion of plastics with time.

Twenty-three sharks (0.17% of those examined) were entangled, each with a single polypropylene band such as is used to secure cartons. The bands were wrapped around the gill region and were prevented from moving toward the tail by the pectoral fins. The severity of abrasion of the skin and of damage to underlying tissues varied and probably depended on the amount of time the band had been in place. Three entangled females were in the late stages of pregnancy with apparently normal litters.

Less than 1% of individuals from each of eight species were entangled, and no entanglement was recorded in six species. No entangled sharks were reported between 1978 and 1982. There was no evidence of an increasing trend in the incidence of entanglement from 1983 to 1993.

Forsyth, Marianne L., Anton McLachlan, and Graham Kerley

Dune Litter Pollution: Its Ecological Impacts With Special Reference to Meiofauna

University of Port Elizabeth, Cape Province, South Africa,

The Alexandria Coastal Dunefield in Algoa Bay in the Cape Province, South Africa has been found to have a substantial amount of anthropogenic litter pollution. This survey involved quantifying and characterizing the litter and investigating the effect of plastic on dune meiofauna.

The total weight of litter items recorded from a beach clean-up over a total distance of 17 kilometers of the beach amounted to 7.5 tons. More detailed analysis of 7 x 100 m subsamples within the clean-up area were undertaken. These comprised 5,397 litter items, representing 742 items per 100 m. Eight percent of the total number of litter items was plastic material, followed by 13% glass, and 7% metal and other items. Packaging constituted almost 80% of plastic items recorded, followed by 12% fishing related items, and 8% miscellaneous items. The litter items recorded were generated from land-based sources and the fishing industry.

As plastic was found to be a dominant item in the sample, the impact of this litter item on the dune meiofauna was investigated. Although the impact of the plastic on the meiofauna as a whole was relatively small, the dominant group, nematodes; showed significant differences in abundance when buried plastic was present.

This study highlights the possible impacts litter pollution could have if allowed to accumulate unchecked in the dunefield. Regular clearing of this area together with sustained enforcement and monitoring of MARPOL Annex V, and local anti-litter campaigns will help to maintain the scenic beauty of the area, as well as the unique ecosystem.

Kirkley, James E. and Kenneth E. McConnell

Marine Debris for and by the Commercial Fishing Industry

University of Maryland, College Park, Maryland, USA

While it is widely accepted by society that the commercial fishing industry contributes to the problem of marine debris, it is less well known that the fishing industry must also contend with marine debris. For example, precious fishing time may be reduced in some offshore fishing areas because vessel crew must remove debris from the gear. In some other instances, debris may even be quite hazardous to fishing crew (e.g., unspent munitions). In this poster, a pictorial essay of illustrative types of debris produced and encountered by industry is presented. The pictures and information were obtained from seven trips aboard commercial scallop vessels operating in the northwest Atlantic between 1991 and 1993., Besides illustrating industry's contribution to the debris problem, it is shown that in the Assateague to Chincoteague area the U.S. military and the federal government contribute substantially to marine debris in the form of military hardware and plastics. Last, it is suggested that bottle/can deposits may significantly reduce the quantity of cans and plastic bottles in the marine environment. Previous trips at sea revealed that fishermen harvested and retained all cans and bottles that paid a return.

Matsumura, Satsuki, Norihisa Baba, Takashi Domon, and Keiichi Nasu

Change of Shape and Ghost Fishing Effect of Released Gillnet in the Ocean

National Research Institute of Far Seas Fisheries, Fisheries Agency Shizuoka, Japan

Lost or discharged fishing nets drift in the sea and continue to catch fish, marine mammals and sea birds. This is called ghost fishing. In order to deal with this problem, the Fisheries Agency of Japan has conducted surveys since 1988 -on the adverse effect of drifting nets on marine organisms. In the surveys that have been conducted in the first two years, some findings were obtained on the elapsed time pertaining to change in the experimental drifting nets, the drifting of lost nets, the configuration of nets, and the ghost fishing efficiencies.

Forty tans (2,000 meters) of monofilament gillnet with 115mm mesh were used for the experiment mainly. The experiments on the time elapsed from the beginning of drifting until the fishing efficiency becomes zero have been done based on l) observations on the number of organisms entangled in the lost nets, in particular the number of fishes and the processes of decomposition and dropout and on 2) a change of the fishing efficiency of the lost nets with the passage of time.

The experimental drifting nets started forming an oblong mass after 3 to 5 days of the deployment.. From the theoretical equation, it was determined that the maximum length of the net represented the fishing efficiency of the exponentially sharp decrease with time.

On the other hand, the investigation of using bio-degradable drift nets has been discussed. The net material is composed of polyester made by some kinds of bacteria. A British company ICI established a technology for mass-reduction of the polyester marketed under the trade name "BIOPOL". A Japanese fishing net company made a gillnet from this material. In the fishing experiment, 3 tans of bio-degradable nets were set between 20 tans and 10 tans of standard nets. As a result, the fishing efficiency of the bio-degradable nets was almost the same as ordinal standard nets. Although, the net will be good for decreasing debris whether at sea or on land, cost and strength might reduce the practicality of using this material for commercial fishing nets.

Newton, Sally and Peter G. Ryan

Using Skua Pellets to Monitor Plastic Ingestion by Storm-petrels: An Alternative to-Destructive Sampling

Fitzpatrick Institute, University of Cape Town, Rondebosch, South Africa

The stomach morphology of petrels and storm-petrels (Procellariidae and Hydrobatidae) precludes non-destructive sampling of ingested plastic particles. This complicates attempts to monitor the abundance and characteristics of plastic ingested by these seabirds which have among the highest levels of plastic ingestion recorded for any marine organisms. One possible way to monitor plastic ingested by petrels is to record the amount of plastic in pellets regurgitated by skuas Catharacta spp. after feeding on petrels.

Subantarctic Skuas C. antarctica are predators that regularly consume petrels breeding at Subantarctic islands; The indigestible remains of their avian prey are regurgitated in pellets, comprised of bones, feathers and persistent stomach. contents (primarily sguid beaks, pumice and plastics). A previous attempt to use skua pellets to assess plastic ingestion among small petrels found several biases, including the under-representation of small particles (<8 mg). However, this result was based on inadequate sampling of pellet contents. Careful sampling of skua pellets collected annually between 1987 and 1990 at Inaccessible Island in the central South Atlantic Ocean suggests that small particles were over-looked by the initial survey, and that skua pellets may be a good indicator of plastic ingestion.

There were seasonal changes in the amount of plastic in relation to breeding activity. Plastic loads are high during incubation, decline once chick-feeding commences, thenincrease during the chick fledgling period due to the large proportion of inexperienced fledglings eaten by skuas (fledglings identified by incomplete ossification). These patterns are consistent with the transfer of stored plastic loads from parents to their offspring among petrels. White-faced Storm-petrels Pelagodroma marina had the greatest incidence of ingested plastic prior to chick feeding (October), but the incidence decreased from 91% in 1987, through 81% in 1988, to 76% in 1989. Similar patterns were found in the mean number of plastic particles per bird over the same three-year period. There was no evidence of consistent inter-annual trends in the amount of plastic in other petrel species for which there were adequate sample sizes in white-bellied Storm-petrel Freaetta urallaria and Broad-billed Prion Pachyptila vittata, breeding at Inaccessible Island between 1987 and 1989.

Storm-petrels are swallowed whole by skuas and thus provide the best information, because there is little possibility of confusion about either the species from which the plastic is derived or the number of prey individuals involved. Both these factors become problems with larger prey items, where skuas may share meals, and a single prey item results in more than one

pellet. The only drawback with storm-petrels is that some 30% of pellets have to be discarded because they contain the remains of more than one prey item.

Schofield, David, Andy Stamper, Brent Whitaker, and Joseph Geraci

A Young Whale, the Victim of Ocean-Borne Plastic

National Aquarium, Baltimore, Maryland, USA

On Thanksgiving Day, 1993, an orphaned pygmy sperm whale, Kogia breviceps, was found stranded in a New Jersey inlet. The animal, which was rescued by the Brigantine Stranding Center, New Jersey, was air-lifted the following day by the Coast Guard to the National Aquarium in Baltimore. There she was placed in a large pool and given round-the-clock intensive care.

The animal was thin, would eat very little, and showed signs of gastrointestinal disease. She listed to one side, swam feebly, and was unable to dive more than a few feet. An examination of her stomach revealed the presence of impacted plastic. Repeated attempts to retrieve the debris were finally met with success, after which the animal's behavior and appetite improved dramatically. In her short stay in Baltimore, she has gained 112 pounds and now weighs 318 pounds.

The National Aquarium in Baltimore's Marine Animal Rescue Program is presently preparing the whale for release back to the sea. A healthy whale now, but will she once again mistake the undulating movement of plastic for that of her primary diet, squid?

Slater, Janet E.

Plastic Ingestion by Seabirds in Tasmania, Australia

Tasmanian National Parks and Wildlife Service, Hobart City, Tasmania, Australia

The stomach contents of 24 dead, beachwashed fairy penguins, Eudyotula minor, 3 short-tailed shearwaters, Puffinus tenuirostris, and 2 fairy prions Pachptila turtur, were examined for plastic ingestion.

Plastic particles were found in three penguins and two short-tailed shearwaters. Articles included pieces of soft plastic, plastic beads, pieces of hard plastic and one lid from a medicine bottle. In one bird, the plastic appeared to have obstructed the passage of food into the intestine, causing the stomach to swell and burst through the body wall.

Evidence suggests that the plastics originate from a variety of sources, and these and the hazards of plastic levels in the seabirds are discussed.

Spear, Larry

Incidence of Plastics in Seabirds from the Tropical Pacific, 1984-91: Relation with Distribution of Species, Sex, Age, Season, Year, and Body Weight

Point Reyes Bird Observatory, Stinson Beach, California, USA

We studied incidence of plastic (number of individuals containing plastic per number inspected) and number of particles per individual in 1453 seabirds representing 36 species of. seabirds collected in the Tropical Pacific, mostly between 110% and 150% longitude over an eight-year period 1984-91. Incidence of plastic was lower in species resident in the equatorial region compared to those that bred to the south or north but wintered in the region, and especially when compared to the species that crossed the tropics in migration between the South and North Pacific. Results of multivariate analyses controlling for species among a group of five Procellariiform species (each with >5% of the individuals containing plastic and for which samples were >= 20 birds) indicated that incidence of plastic was significantly higher in females compared to males in one species, the Stejneger's Petrel, Pterodroma longirostris. Seasonal and age-related patterns in incidence of plastic, number of particles, and particle type (pellet vs. user-plastic) indicated that (i) degradation for an individual particle in the stomach of a procellariiform required about 6 months and (ii) no support existed for the hypothesis of "intergenerational exchange" (i.e. the regurgitation of plastic by parents to young). We hypothesize that higher incidence of plastic in heavier birds (for a given species, age group and year) indicated that higher quality birds fed more often in areas where one would expect higher densities of plastic and natural food, such as convergences, fronts, and eddies. A significant decrease in body weight with number of particles among individuals who contained plastic is the first solid evidence for a negative effect of plastic on fitness in seabirds. The indication that higher quality individuals may be more susceptible to plastic pollution has serious implications regarding health of some seabird populations.

Spence, Lundie

The Death of a Whale: Using a Stranding Incident for Public Education

University of North Carolina Sea Grant,, Raleigh, North Carolina, USA

A juvenile, female sperm whale was stranded on Wrightsville Beach, NC, December 11, 1992. She died within 45 minutes of the stranding. The incident was handled by the local Marine Mammal Stranding Team who arrived on the scene within 30 minutes of notification. The first priorities were crowd control, securing the carcass farther up on the beach with two front-end loaders, and recording the external observations. The local marine mammal veterinarian performed a cetropsy. The stomach contents

contained little except plastic debris. This included a bleach bottle, 30 feet of polypropylene line, a fishing float, plastic caps and a large piece of what is thought to be unprocessed natural rubber. A few squid beaks also were found. There were no other food remains in the stomach. Members of the Marine Mammal Stranding Team described the whale's condition as emaciated. Her skull was prominent, stretching the skin with little fat to fill out the spaces. Thus, the death of the whale was attributed to malnutrition brought about by the ingestion of plastic debris.

Fortunately, an amateur video photographer filmed the whale and the necropsy. This footage, combined with interviews from the members of the Marine Mammal Stranding Team, has been organized into a 17-minute educational video. This video will be ready for sale in March, 1994 and will be shown on North Carolina public television in late spring.

The production and distribution of the video, "The Death of a Whale" is a direct response to the need for the public awareness. The footage is unique. The reaction of the small crowd during the necropsy parallels the emotional response of the pilot viewers of the video -- one of disbelief and great sadness. Viewers want to know what they can do to prevent this tragedy in the future. Thus, the video makes an impact on its viewers and increases awareness of marine debris issues.

Teas, Wendy G. and Wayne N. Witzell

Impacts of Anthropogenic Debris on Marine Turtles in the Western North Atlantic Ocean

National Marine Fisheries Service, Miami, Florida, USA

(Presented in the Manuscripts section.)

SESSION III POSTERS

Sources of Marine Debris: Vessels

Alarcon Daowz, Gildardo

Mexican Navy Participation in Activities for the Protection of the Marine Environment: Marine Debris Cleaning Operations

Armada de Mexico, Coyoacan, Mexico

Mexican Navy Districts perform cleaning operations on beaches, in harbours, coastal lagoons and bays and enforce governmental policies for the protection of the marine environment.- These activities are carried out through special units localized in every port called "Unidades de Protection al Medio Ambiente Marino" (Marine Environment Protection Units).

The marine debris collection is carried out in collaboration with other federal agencies and with public participation. This is realized at two different stages: the first is through continuous but short range operations (usually twice a week in a reduced number of beaches or waterfront of some piers), performed by Navy personnel. The second is a larger scale operation conducted on a monthly basis and during special celebrations such as the International Earth Day, the World Environment Day, etc., and is performed by Navy personnel, Navy service conscripts and the general public, working in more extensive areas of beaches and waterfronts.

Each month, every Navy District writes a report of these activities, in which is included the types and amount of debris, spatial distribution and some other useful information. At the offices of the Director for the Protection of the Marine Environment, this information is received and analyzed to determine patterns and important sources of pollutants.

In this poster, results from 1993 are displayed, showing differences among coasts in which main activities range from self-consumption fisheries to tourism and the oil industry. Tourism and fisheries seem to be the activities related to the largest amounts of marine debris produced. However, further information is required in order to know the contribution of domestic and municipal wastes. With this purpose in mind, Mexican Navy authorities have recently introduced some criteria to classify the debris collected, with the aim of obtaining higher quality data, thus enabling identification of different sources of coastal and marine debris.

Further discussion is focused on the strategy to improve the cleaning operations and on the alternatives for reducing the amount of debris released to the marine environment.

Topping, Paul

National Marine Plastic Debris Program

Environment Canada, Hull, Quebec, Canada

Environment Canada initiated the Marine Plastic Debris Program to address the issue as part of a commitment made under the Green Plan, a major environmental funding effort launched in 1990 by the Government of Canada. The Program will focus on collecting survey data and promoting awareness of pollution prevention, and linkages will be made with broader waste reduction efforts. Much of the Program is derived from recommendations made to Canada's federal government at a 1989 workshop held in Halifax, which involved almost all interested groups. Goals and objectives have been set out in broad terms for the next four years, and activities are now underway; A project to survey the extent of plastic debris in Canada's marine environment has begun -and some communications services that promote awareness of the issue nationally are now available, namely a newsletter, the Messages Program, and ENVIRO-TIPSHEET. Products that deliver a preventive message are being developed and include a pamphlet, poster and educational survey kit.

Zilligen, Jil and Barbara Miller

Zero Solid Waste Discharge Program

Center for Marine Conservation, San Francisco, California, USA

Each year, International Coastal Cleanup data reveal that a significant portion of marine debris results from improper waste disposal by ships. Because marine debris poses many problems and because there are now eight ocean regions designated "Special Areas," or no discharge zones, the Center for Marine Conservation (CMC) began a Zero Solid Waste Discharge Program. The program sought to determine how shipboard waste could be better handled so that no solid waste is disposed of at sea. CMC worked with Matson Navigation Company to develop a model zero discharge program in which no solid wastes, except food wastes, would be dumped overboard. This program has become an example for ships operating in the Gulf of Mexico, which has recently been designated a Special Area under MARPOL Annex V.

During this study, CMC analyzed what type of goods are brought onto the ship; the types of packaging used, and the types of' waste generated on board a typical vessel. The waste generated on board during an average cruise was catalogued and the composition and amounts of the principal wastes generated were calculated. From this information, wastes that could be reduced or eliminated were identified as were ways in which APHIS' wastes could be reduced, and what type of reception facilities would be necessary to accommodate the trash.

CMC then worked with Matson to prevent as much potential trash as possible from being brought aboard in the first place by: identifying unnecessary packaging and requesting less packaging

from vendors; removing excess packaging at the port; substituting reusable items for disposable items; and encouraging bulk containers for galley items. Matson developed an on-board recycling program, a system for storing trash on board until in port, and is working toward an effective education and incentive program for the captain and crew.

The program, piloted aboard the "SS Matsonia" allows for the evaluation of waste reduction measures that have been undertaken and observation of crew response to the program. Based on the results, CMC is developing a Zero Discharge Manual and promoting the pilot program through the media and shipping journals.

1 APHIS (Animal and Plant Health Inspection Service). The U.S. Department of Agriculture requires that food contaminated refuse from vessele that have called in foreign ports be incinerated or sterilized to prevent the spread of plant pests and livestock or poultry diseases in the United States.

SESSION IV POSTERS

Sources of Marine Debris: Recreational Use

Adcock, Walter

College of William and Mary, Hampton, Virginia, USA

MARPOL and Clean the Bay Day

Marine debris, particularly plastic waste, has been an age-old contributor to the overall degradation of the marine environment. Plastics, in the form of cigarette filters, caps and lids, food bags, and straws have made up the majority of the debris that has washed up along the shoreline of the Chesapeake Bay in recent years. The Convention for the Prevention of Pollution by Ships, through the Marine Pollution Treaty, has created restrictions for the dumping of waste in order to help preserve the quality of the marine environment.

On December 31, 1988, Annex V of the Marine Pollution Treaty (MARPOL) took effect - outlawing the dumping of plastics at sea. A primary intent of the amendment was to stop further killings of marine mammals and birds that have died as a result of the presence of plastics in our oceans. Many have been known, for example, to mistake certain types of plastics for food or become helplessly entangled in stray fishing nets.

The effectiveness of Annex V, however, has come into question. Since 1989, the Center for Marine Conservation, through its annual beach cleanup known as the Clean the Bay Day, has collected debris that has washed up along the shores of the Chesapeake Bay. The majority of the trash collected during the four years of the cleanup has been plastics. Plastics have contributed to more than fifty percent of total debris collected during the past two years. In addition to collecting debris, the cleanup has been responsible for evaluating the waste, in part by determining the sources from which the debris originates. Galley waste, operational waste, and commercial fishing waste -- all of which include to varying degrees the dumping of plastics by ships - have been the greatest sources of waste collected in the past two years.

Annex V of MARPOL and the ships that frequent the waters of the Chesapeake Bay need to work together if the dumping of plastics is to subside. Ocean pollution is a continuing problem, and the overall health of the Chesapeake Bay plays a big part in its solution.

Bartholomew, Susan

North Carolina Big Sweep: Don't Splash Your Trash: Educating Recreational Water Users

North Carolina Big Sweep, Raleigh, North Carolina, USA

North Carolina Big Sweep has successfully involved recreational -water users (boaters, beachgoers and fishermen) in our cleanup as a result of an aggressive educational and awareness campaign. The poster will feature mounted examples of Big Sweep educational materials including:

.Richard Petty "Don't Splash Your Trash" poster: More than 10,000 copies of this poster were distributed to piers, marinas and bait and tackle shops throughout North Carolina. NASCAR driver Richard Petty, hero to many sportsmen, is the perfect role model to deliver Big Sweep's anti-litter message.

Boat litter bag: The prevalence of bait cups, beverage containers and fishing line in 1991 and 1992 prompted Big Sweep to develop a reusable litter bag-for boaters. Patterned after the lingerie bag used to wash delicates, our sturdy mesh litter bags are designed for years of litter collection by recreational anglers. More than 9,000 bags were distributed individually to boaters and. fishermen and to participants of saltwater and freshwater fishing tournaments.

R.J. Reynolds "Don't Leave Your Butt on the Beach" materials: For the past several years, cigarette butts have been the number one item collected along Tar Heel inland and coastal 'shorelines. Consequently, R.J. Reynolds Tobacco Co. and Big Sweep launched an adult education campaign, that included billboards, tentcards, bumperstickers and pocket ashtrays designed to raise awareness of cigarette butts as litter. Pocket, ashtrays are foil-lined vinyl pouches that can be slipped into a smoker's pocket for easy disposal of extinguished cigarette butts.

"Did You Kill This Whale," animal entanglement/whale brochure: In December 1992; a three-year-old spermwhale washed ashore a North Carolina beach and died, its stomach engorged with plastic debris. The brochure poignantly points to the danger posed by litter in the ocean and waterway environment and the importance of aquatic stewardship.

Photos of recreational water users participating in cleanups and trash fishing tournaments.

Big Sweep/Jantzen Clean Water sportswear droptags -- Jantzen, Belk and Big Sweep joined together to promote water quality awareness. Drop tags were attached to Jantzen sportswear and swimsuits in seven' North Carolina Belk stores.

Graph of North Carolina's increasing volunteer efforts over the past seven years: Big Sweep's volunteers have increased from 3,000 volunteers in 1987 to 12,000 volunteers in 1993.

Bortman, Marci L. and R. Lawrence Swanson

The Great Garbage Chase

University of New York at Stony Brook, Stony Brook, New York, USA

The Great Garbage Chase is an imaginative lo-minute video for children updated for the U.S.. Environmental Protection Agency from a filmstrip created almost two decades ago by Louis Iozzi of Rutgers University for the National Oceanic and Atmospheric Administration; It emphasizes the sources, transport, and fate of marine debris in the New York/New Jersey area and is geared toward primary school-age children. The video combines illustrations and photographs and uses., as its main character, two seagulls to answer the questions, "Where does the trash on the beach come from?", and, "Why is the trash on the beach usually in a straight line.?" It reviews the various sources-of marine debris (e.g., boaters, recreational users of the beach, street litter, and combined sewer overflows) and the effects of tides, currents, and winds to transport the floating trash onto the beach. The video ends with recommendations to youngsters to help prevent trash from entering the marine environment and washing up on beaches (e.g. stop littering, start recycling), and discusses improvements that have been made by federal and state agencies to combat floatable debris.

De la Garza, Angela

Boater's and Angler's Pledge: A Regional Effort to Help Protect Inland and Coastal Waters Through Education and Public Awareness

Texas General Land Office, Austin Texas, USA

In order to keep our waters free of debris, it is critical to have the participation and cooperation of the boating and fishing communities. Boaters and marine recreational anglers use coastal waters and tributaries extensively during their activities. The Boater's and Angler's Pledge was developed as a regional effort to help protect inland and coastal waters through education and public awareness. This program is part of an overall effort to educate boaters and anglers in all the Gulf Coast states. It is coordinated by the federal Environmental Protection Agency's Gulf of Mexico Program and is implemented by the individual Gulf States. Each person who takes the pledge receives program materials such as boat decals, rulers to measure fish, and wallet cards with helpful numbers from their state coordinator. The key words used in the pledge commitment are these: I Pledge to: Transport to shore, for proper disposal, all trash generated aboard my boat, especially plastic, glass, and metal; Make every effort to prevent accidental loss of food and drink containers, fishing gear, and other debris from my boat; Retrieve for proper disposal onshore, plastic refuse, cans and other man-made debris I find floating in navigable waters; and, Encourage fellow boaters and anglers to take the pledge and help to protect our lakes, rivers and beaches.

Marine debris is trash discarded in -waters, including lakes, rivers, the Gulf of Mexico and its bays and estuaries. Marine debris comes from many sources such as recreational boaters and anglers, commercial fishing vessels, charter boats and merchant ships. This debris includes cans, bottles, plastic trash and ice bags, fishing line, and other household garbage. Oil and filters are also common pollutants. Marine debris has far reaching effects. It not only harms the environment, it hurts the economy. When trash is dumped into waters, it doesn't go away. Winds and currents can carry it back to shore or even move it from inland waters to the Gulf of Mexico. Since most of it is plastic, it can last for hundreds of years. Each year thousands of mammals, birds, fish and other creatures are killed, injured or maimed by swallowing plastics or becoming entangled in discarded nets or monofilament fishing line. Wildlife are not the only ones affected by marine debris. Boaters report that hundreds of engines are damaged when plastic bags and other debris clog water intakes or are caught in propellers. Debris also damages or tangles fisherman's nets. Trash on the shoreline is not only an eyesore, it can also become a serious health and safety problem.

Federal and state laws prohibit disposal of plastic in all waterways. In spite of civil and criminal penalties for these violations, there has been little obvious effect on disposal habits of many marine anglers and recreational boaters.

The ultimate goal of this broadbased educational campaign is to effect a behavioral change in waterway users who are ignorant, careless, or unaware of the cumulative effects of marine debris pollution. The Boaters and Anglers Pledge program is designed to seek support, commitment, and action by appealing to the environmental conscience of recreational waterway users. Success of the campaign will be highly dependent on many cooperating groups and organizations, but most especially on person-to-person contact. Boaters and anglers targeted by the program are more likely to make a conservation commitment by being personally challenged by friends and fellow boaters and anglers. The Boaters and Anglers Pledge Program hopes to make it-the "in thing" to display pride in our coastal and marine resources, and to render improperly disposed of trash as socially unacceptable. As regional promotion, pledge commitments, logo familiarity, and participant actions on the waterways increase in scope and visibility, the significance and effect of this program should, grow as well. This program will be deemed successful when boaters. and anglers themselves make this their project!

Dubsky, Karen

COASTWATCH Europe Survey Results for Slow and Non-degradable Litter on the European Coast, 1993

COASTWATCH Europe Network, Dublin, Ireland, UK

A coastal survey including litter items found in the splash zone and tidemark/intertidal has been carried out annually in Europe since 1987. From national beginning (Ireland) and small

international pilot in 1988, the survey - run with volunteers over a two week period each autumn - has yielded > 10,000 site returns for compiling and analysis every year for five years now.

The paper reviews autumn, 1993 results of over 14,00,0 sites (500 meter shore each) in 19 European countries, with special emphases on: (i) non- and slow- degradable litter of mainly marine and port origin (fishing nets, packing straps, polyurethane and polystyrene); (ii) beverage containers (on average counts per site or region separating cans, plastic, and paper outer drinks containers; and, (iii) sewage related waste.

Some comparisons between countries and seas - Baltic, Northwest Atlantic, Southwest Atlantic, Mediterranean and first limited Black Sea results - are made. Finally, trends with time are suggested and these discussed in the context of both economic parameters and political initiatives such as sales; use, reuse, waste management, legislation and enforcement, as noted by national CWE coordinators. Recommendations to reduce marine litter are presented.

The paper will include overheads and slides. An interactive computer display programme showing litter data for select countries down to 500 m survey unit is available.

Gottshall, Ginnie

Balloons

Alliance for a Living Ocean, Bel Air, Maryland, USA

At the Center for Marine Conservation's first annual International Coastal Cleanup coordinators' meeting in October of 1989, the coordinators were urged to have all volunteers look for and report marks of identification on the debris they pick up.

This message was especially meaningful to us because, in July 1988, we found on the beach in Beach Haven, New Jersey, a balloon marked, "Easter at the White House, 1988". We reported this to CMC who phoned the White House. Since that time, the White House has not used balloons at outdoor events.

Learning early that reporting identifiable debris to its source, through CMC and directly, brought results, we began a campaign to have our volunteers be extra careful about examining debris. We discovered that very little of the debris that washes up on the New Jersey shore bears an identification...except for balloons... one of the debris items most hazardous to marine animals.

We discovered that the use of imprinted balloons for advertising and commemorative purposes was on the rise so we composed a letter to be sent to the individuals and companies whose balloons we found. This letter, without being too long, details the dangers balloons pose to marine life in a way to evoke sympathy for the victimized animals, and it provides some surprising facts and figures.

During the past three years we have sent dozens of these letters a year, and while most are not answered, we have noticed that there are no repeats from the parties contacted. It is a slow process but it brings results because our reporting of the problems of balloons in the environment has attracted much attention from the press, including metropolitan dailies.

The most recent letter (January 1994) went to the mayor of Philadelphia regarding the release of balloons at a major, center-city parade. Those balloons were not marked, but were seen on television.

Releases of large groups of unmarked balloons are, fortunately, somewhat on the decline. Our method of dealing with these was through petitions. Beginning in 1988, we took petitions to the public by having a table at fairs, festivals, etc., with information about the problem and with petitions on which we obtained, ultimately, thousands of signatures. We believe our petitions helped, together with others, to cause the Disney Corporation to discontinue balloon launches.

The balloon letter can be made available to all those attending the Conference, for use in their own areas. It will be on the poster with its history and intention and with the encouragement that it be used, worldwide.

In addition to the balloon letter, we have, for use on the poster, dozens of balloons with identifying imprints, letters we have received in affirmative answer to ours, and the latest news report of balloons discovered inside a marine animal, for use in a petition campaign.

Holden, Nerina

Marine Debris Pollution on the Beaches of Trinidad, West Indies

National Rivers Authority, Worthing, Sussex, England, United Kingdom

There is increasing concern about the amount of man-made debris littering shores in all parts of the world. This pilot study aimed to assess the marine debris pollution of beaches in Trinidad, West Indies, a task not undertaken to this extent on the Island before.

The standing stock of debris on beaches on all coasts of this island, and one of the westerly isles between Trinidad and South America, was assessed from one collection at each of the sites visited. The collection involved bagging removable debris greater than 2 cm in length from five 1 m transects that ran from. the water to the first obstruction/vegetation. Debris was returned to the laboratory where it was categorized by composition and examined by weight and number of items collected,

From the survey, it was found that the majority of debris items on the shores of Trinidad were plastic or glass and that these

were predominantly present as small pieces. 30% of all items collected were glass (33% by weight) and 44% were made of plastic (34% by weight). Loading per meter length of beach varied from 10g/m to 1112g/m. Gross pollution was found on the central and northern shores of the sheltered Gulf of Paria, which houses two large towns with busy ports. Debris items were largely identifiable as of local origin by familiar packaging. It would appear that Trinidad is responsible for most of the litter on its shores, with beachgoers and "litter bugs" inland causing problems along the beaches.

Education about, and enforcement of, litter awareness can only improve the situation in Trinidad. If the problem is not tackled soon, the cost to Trinidad of belated clean-up operations will be high.

McGilvray, Frazer

Marine Debris on United Kingdom Beaches

Marine Conservation Society, Hairmyres, East Kilbride, England, United Kingdom

BEACHWATCH '93 was a campaign designed to raise awareness of the problem of litter on Britain's beaches. Its key event was a beach clean on 18 and 19 September 1993. This involved removing debris and collecting data. The campaign formed part of 3 larger campaigns:

1) The Marine Conservation Society's Ocean Vigil Campaign
2) Reader's Digest Beachwatch Campaign
3) The Center for Marine Conservation's International Coastal Cleanup

The BEACHWATCH beach clean-up took place on 121 beaches covering a total of 125 miles in 35 counties throughout the UK and included the Channel Islands and the Isle of Mann. 1,238 people took part in the collection and categorization of 32.7 tonnes of debris.

The campaign shows that there is a worrying level of pollution from a number of sources around the UK's shores. At the same time, it has highlighted the need for effective enforcement of existing legislation and the concern of the public towards the beaches. and waters around the UK.

Recommendations: The BEACHWATCH '93 campaign has shown. inefficiencies in many areas regarding legislation, both its structure and its enforcement. It has also shown that the public want to contribute time and effort towards the marine environment but cannot do it alone. Local authorities must take greater responsibility for their own areas of control so as not to leave the public to clean it for them. However, MCS has developed "Adopt a Beach", a project designed to encourage people to clean and monitor their beach or coastline on a regular, long term basis.

Table 1. Breakdown of debris types

Type of Material	Total Number Found	Percentage Breakdown
Plastic	59,854	52.1
Polystyrene	7,538	6.6
Rubber	1,639	1.4
Wood	1,850	1.6
Metal	12,706	11.1
Sewage Related Debris (SRD)	12,799	11.1
Paper	5,795	5
Cloth	1,763	1.5
Glass	10,934	9.5

We recommend that encouragement be given to the countries who have not yet ratified MARPOL annex V and financial support be offered to developing nations to allow them to combat marine debris.

Plastics and other disposables in sewage (PODS) must be stopped. We support the "Bag it and Bin it - Don't flush it" campaign to end PODS. Education not to flush these items is needed and should be encouraged.

The continuation and expansion of projects like BEACHWATCH are necessary to maintain pressure on polluters and authorities as well as to monitor the change and hopeful reduction of marine debris.

Rice, Nan

Marine Debris Education in Southern Africa

The Dolphin Action and Protection Group, Fish Hoek, South Africa

In 1987, concerned by the increasing hazards which plastic pollution was posing to the South African marine environment, the Dolphin Action and Protection Group (DAPG) launched a national campaign "Save Our Sealife: Prevent Plastic Pollution". This has been one of the most successful campaigns yet run by DAPG, and has had far-reaching effects on the public, making "plastic-pollution" a household word in South Africa. DAPG has established a national clearing house on marine plastic pollution and wildlife entanglement where the public and media can obtain educational literature and general information.

One of the main aims of the campaign has been to create an awareness among the various sub-groups of society and to

translate this awareness into effective individual action. This involved targeting merchant shipping companies, the South African Navy, commercial fishing companies, yacht clubs, construction, commercial and industrial companies, schools, and many conservation and public interest organizations as well as the general public. Large numbers of information pamphlets and stickers were distributed, beach clean-up programs were instituted, and manufacturers of especially harmful products were encouraged to use alternative technologies. Some examples of successful product substitution include the phasing out of 6-pack yokes, removal of packing straps and plastic liners from fishing bait boxes, and the design of integral caps and seals for a variety of marine lubricant bottles. More generally, there has been pressure to reduce overpackaging and to introduce refill packs.

Awareness was also created among government departments and South African legislators and in 1988 the campaign was tabled in Parliament when pamphlets were distributed to members of all Houses. South Africa promulgated MARPOL Annex V regulations in 1991 and the following year DAPG launched its MARPOL Annex V Educational Project with the specific aim of educating the commercial fishing industry about the hazards of plastic, pollution and about the regulations. This project, brought about by presentations, literature and notices on vessels and at harbours, was extremely successful in changing disposal practices.

The Prevent Plastic Pollution campaign has extended to Antarctica, Namibia and islands in the southern Atlantic and Indian Oceans. Under its umbrella DAPG began working on the high seas drift/gillnet issue in 1988 to reduce incidental mortality of non-target species from both active and "ghost" nets. As a result, anti-driftnet legislation was promulgated in both South Africa and Mauritius, and a computerized list of Asian fishing vessels operating in the Indian, Atlantic and Pacific oceans was compiled and distributed internationally to facilitate the efficient tracking of driftnet vessels.

Ryan, Bruce

Underwater Debris Cleanup Project

Center for Marine Conservation, St. Petersburg, Florida, USA

Marine debris found on beaches around the world is a problem that is easy to see, and one that many people have volunteered to cleanup. But what about the trash found underwater? This problem is not seen by the average beach user, but trash does lie hidden beneath the water.

Encountering underwater debris is one experience that SCUBA divers wish they did not have. But divers around the world are part of the growing number of volunteers helping to identify the sources of trash. Now we have eyes underwater helping to tell the story about trash we cannot see from land.
Among the more than 200,000 volunteers who helped at the 1993

International Coastal Cleanup were several hundred SCUBA divers, who used their expertise to collect harmful debris that was entangled underwater. Groups of divers from Norway, Israel, Colombia, California, Texas, Ohio and Florida, and other sites coordinated underwater cleanups to remove snarls of monofilament line, fishing nets and other kinds of man made debris that pose a danger to marine wildlife and divers.

The Center for Marine Conservation's Underwater Debris Program involves divers who have an intimate relationship with the underwater environment. The program educates divers and the general public about the hazards of submerged marine debris. The underwater cleanup encourages partnerships with leaders of dive certification organizations, dive shops, clubs, boat charter operators, community organizations and others. Some materials have already been developed to educate divers in the proper way to remove debris found underwater.

Schrader, Betsy

SPI/NOAA/CMC Marine Debris Print Public Service Campaign

Center for Marine Conservation, Washington, DC, USA

Government agencies, conservationists, and industry leaders have repeatedly emphasized that legislation alone will not eliminate marine debris. Education programs are crucial to reducing the marine debris problem. To this end,, in 1987, the Society of the Plastics Industry (SPI), the National- Oceanic and Atmospheric Administration (NOAA) and the Center for Marine Conservation (CMC) launched a national public service campaign to encourage the proper disposal of plastic waste.

A series of print public service advertisements (PSAs) were developed focusing on various sources of marine debris from recreational boaters to anglers to commercial vessels. In 1993, new PSAs were developed to give a fresh, new look to this continuing campaign.

This display illustrates three new PSAs which have been distributed for printing in over 60 publications, including sport fishing journals, boating magazines, marine trade publications, and others. The message of the PSAs range from informing boaters of the aesthetic destruction of the environment caused by littering plastic waste, to communicating that improper disposal of trash is not only illegal but also endangers marine life.

Schrader, Betsy

Marine Debris Outreach and Education Campaign

Center for Marine Conservation, Washington, DC, USA

Plastic debris in ocean and coastal areas causes problems for wildlife, boaters, and beach-goers. Sources of plastic debris encompass both ocean-based and land-based sources. Ocean-based

sources include commercial fishing vessels, merchant shipping fleets, passenger cruise liners, military vessels, oil drilling rigs and platforms, and recreational boaters. Land-based plastic debris gets carried seaward via storm and sewer drains and other outlets.

Education has been widely recognized as a crucial element in reducing marine debris. In 1988 the National Oceanic and Atmospheric Administration (NOAA) contracted the Center for Marine Conservation to establish and operate two Marine Debris Information Offices (MDIOs), one on each coast of the U.S. The goal of the MDIOs is to help reduce the amount of debris entering the marine environment by raising public awareness of the problem through education.

To that end, the MDIOs educate various marine user groups and the general public on the roles they play in contributing to the marine debris problem, and the harmful effects of this pollution on wildlife, boater safety, and local economies.

Education efforts focus on the positive actions that citizens and industry leaders can take, to remedy this problem, such as participating in community efforts such as beach cleanups, boater awareness days, and port recycling programs, and educating their peers, colleagues and others on the issue. The MDIOs also provide information on MARPOL Annex V, the Marine Plastic Pollution Research and Control Act (MPPRCA) and associated U.S. Coast Guard regulations to boaters, sport fishermen and other marine user groups and industries.

With support and funding from the Society of the Plastics Industry (SPI), the Center for Marine Conservation has also developed educational tools and conducted hands-on outreach. efforts, including promoting a "Stow It - Don't Throw It" theme at fishing tournaments. By enlisting the cooperation of tournament organizers, CMC has encouraged participants at major tournaments to bring all vessel wastes back to shore.

Through CMC's efforts, NOAA's MDIOs have become known to the press and media as the primary source of information on the marine debris problem. CMC and MDIO staff frequently conduct briefings, seminars, and presentations on the marine debris issue for the public, the press, educators, and industry representatives. Over the past five-and-a-half years, NOAA's MDIOs have responded to over 60,000 requests for information on the marine debris problem.

Sevin, Jennifer

Officer Snook Program

Officer Snook Program, USCG, Coral Gables, Florida, USA

The Officer Snook Program is a United States Coast Guard sponsored outreach project which educates elementary school age children about the problems of marine debris. Officer Snook is a

cartoon fish who encourages the youth to help make a difference today so we can all share a better tomorrow.

In 1992, the Officer Snook Program was initiated by Miami Beach Senior High School Ecology Club President, Jennifer Sevin, who is now the outreach coordinator. To date, over 25,000 elementary school students have been introduced to the Officer Snook Program, which is now spreading across the national with the help of the United States Coast Guard. The program is being presented and exhibited at marine conferences and conventions; and both high school students and adults are being trained by Jennifer to be mentors of the program.

The Officer Snook Program consists of a 45 minute presentation which includes the Center for Marine Conservation/NOAA video entitled, "Trashing the Oceans." The program also includes hands-on activities, slides, and frequently a United States Coast Guard representative speaks about marine debris and U.S. maritime laws and treaties, and answers questions from the students. All students receive a complimentary Officer Snook educational coloring and activity book. Officer Snook T-shirts are given to all winners of the essay and drawing contest which is held at each school. An Officer Snook Curriculum Book is available to help teachers follow-up on the program.

The Officer Snook Program leaves students with a sense of compassion of our planet, and the hope and determination to make a difference. In turn, the children educate their parents, family, and friends about the marine debris problem, helping to expand the awareness, knowledge and understanding that the Officer Snook Program gives them. Beach and bridge clean-ups and school-wide recycling programs are just some examples of Officer Snook activities.

The goals of the Officer Snook Program are to preserve our natural resources, start recycling programs at all of our nation's ports, encourage smaller packaging of products, expand the use of recycled materials, and continue the education and awareness of our youth about marine debris problems throughout the world.

Slater, Janet

An Integrated: Four Year Marine Debris Survey/Monitoring and Education Program in Tasmania, Australia

Tasmanian National Parks and Wildlife Service, Hobart City, Tasmania, Australia

This (poster) presents, the results of a four year (ongoing) statewide survey of marine debris around the coastline of Tasmania, Australia, and also presents how the results were used to design a comprehensive marine debris education program that has successfully reached the fishing industry in Australia and the wider community, and achieved changes to reduce the amount of debris generated by the fishing industry.

The four year survey was designed and established by Janet Slater, a scientific officer with the Tasmanian National Parks and Wildlife Service in response to the growing problem of entanglement of marine- life in debris. It was the first marine debris study to be established in Australia and remains the only statewide study of the problem in this country.

Tasmania is an island state at the southern extremity of the continent of Australia and has the largest coastline of 5,400 km. Tasmania is bounded by four oceans: the Pacific and Tasman Oceans to the east; Indian ocean to the west and Southern ocean to the south. These waters comprise the core of the world's smallest marine province and also include a province with the highest known marine plant diversity in the world. The nutrient rich temperate waters around the state support an abundant fishery which is heavily exploited by local, national and international fishing fleets which have in recent years been the source of much debris problems, such as entanglement of marine mammals, bycatch problems and coastal pollution.

The growing problems of entanglement of resident Australian fur seals, Arctocephalus pusillus doriferus (one of the four smallest seal populations in the world) in fishing debris, especially plastic strapping bands was the specific reason why the marine debris survey program was established in January 1990.

The aim of the survey program was, and still is, to record the quantity, types and distribution of the debris, identify and target sources through education and legislation and assist in making changes. It also aims to monitor the rate of debris accumulation over time both on a seasonal and annual basis.

Results have been analyzed on a regional as well as a statewide basis, so that data can also be related to land use as well as oceanic/coastal use. For example, Tasmania's west coast is virtually uninhabited wilderness with most of the adjoining land in a National Park or uninhabited due to the rugged terrain. Thus, marine debris can be presumed to be oceanic in origin.

Surveys were conducted by National Parks and Wildlife scientific and ranger staff as well as the general public over a representative geographic range of Tasmania's coastline, from populated city beaches through to our most isolated wilderness areas.

Between January 1990 and January 1994, a total of 450 surveys were conducted at 236 sites covering a distance of 550km. Fifty states were regularly monitored to collect temporal data. Of the debris recorded to date, plastic items were the most frequently occurring comprising 70 percent of all debris. Of this total, 40 percent of plastics are sources to both commercial and recreational fishing (rope, nets, line, bait straps, buoys, floats).

On a statewide basis, this represents an average of approximately 454 debris items per/km. On remote stretches of coastline of the southwest of Tasmania, where human visitation from the land is rare, the average number of items/km is in some places 600-1000,

indicating the high rate of discardation of debris in the ocean. A high (59 percent) of debris was made up of items identified as harmful to wildlife by this Department and the United States Parks and Wildlife Service (Manski et al. 1991). The most frequently occurring and widespread of all debris items was fishing rope (13.25 percent), 50 percent of which was identified from the trawl fishing industry. Trawl net offcuts currently account for 60 percent of entanglements of Australian. fur seals in Tasmanian waters (Kirkwood et al. 1992). Plastic strapping bands comprised three percent of entanglement debris in the first two years of the survey but have declined to 1.8 percent since 1992. This could be attributed to the change of bait packaging now being used by the fishing industry.

Of domestic debris items, by far the most frequently occurring items are plastic bags and sheeting which comprise thirteen percent of the total debris. This figure has remained constant over the past four years, despite widespread public awareness campaigns, plastic bags continue to increase as a major packaging medium in the community.

Statewide, there has been an overall slight decrease of ten percent of plastic debris over the past four years and a 40 percent decline of non-plastic. bottles and cans. However there has been a 20 percent increase, of foreign source plastic debris, predominantly of Japanese origin on our most remote coastlines.

A comprehensive education program has evolved with the survey program resulting in the growth of Australia's first fully integrated scientific and educational program on marine debris. Achievements have been:

- The first statewide marine debris study for any Australian state
- Scientific study of entanglements and ingestion of marine debris in marine fauna.
- An educationprogram which has targeted the fishing industry and associated manufacturers; the Judiciary and the wider community through community participation in the marine debris surveys; television advertising, publications, stickers and posters; regular media reports; input to Fishing Industry Training courses; and the development and implementation of school marine debris science projects;
- The first prosecution under MARPOL V 73/78 legislation for Australia
- Contribution of data to the International Maritime Organization; CMC (USA); Commonwealth fisheries management and the Japanese fishing industry and government.

Pre- and post MAPPOL V 73/78 ratification data so that monitoring of this legislation could be undertaken.

- A major redesign of fishbait cartons to reduce strapping, bands, and the subsequent local reduction of entanglement of marine mammals in this debris.

The results of the Tasmanian study and the relationship of this data to both international surveys and other parts of Australia, and the possible effects of the education programs and legislation on the quantity and types of debris will be discussed in this paper.

Snyder, John

Techniques for Prevention of Marine Debris at Glacier Bay, Alaska.

Glacier Bay Outfitters, Littleton, Colorado, USA

The prevention of marine debris should be an integral part of a complete visitor management and education program. The background of the poster will display a map of the Glacier Bay National Park region. This will illustrate that the recreation experiences- offered in this region are predominantly marine based. Individual photographs that identify the type and locations of diverse marine recreation experiences that we offer will be mounted -on the map. A graphic representation of the increase in visitation to Glacier Bay will visually describe the growing-recreation use pressures that the area has received. The two types of marine debris prevention techniques that we use will be displayed in story board fashion. Those two techniques include Visitor Management and Visitor Education.

The major elements that comprise the Visitor Management techniques include: (1) The importance of using the appropriate visitor/guide ratios for each type of recreation activity; (2) the need to train and use only licensed guides, outfitters, naturalists, and boat personnel; (3) the proper use of communications procedures and equipment; (4) weather training and the use of weather monitoring equipment for recreation personnel; (5) tide tables, and the appropriate marine charts or guad maps must be in the possession of all recreation personnel in weatherproof containers; (6) contingency plans and the availability of backup transport, medical, and communications support are required for all recreation activities; (7) management policy advocates catch and release sportfishing; (8) management advocates the photographic procedures established by Alaska Department of Fish and Game for recording trophy fish; (10) for anglers and kayakers using the shore, everything that is packed in must be packed out; (11) record and report all bear sightings and encounters.

Marine based recreation activities in the Glacier Bay region include sportfishing, whale and other marine mammal viewing, charter and tour boat operations, and kayaking. The region that we operate in is as large as New England and has four tides a day that can be over 20 feet in size. This area of Southeast Alaska also has the world's largest population of bears. Given these conditions, the major elements that comprise our Visitor Education techniques include: (1) an introduction to the type of recreation experience we will be offering which includes an explanation of the relevant regulations and the importance of preventing marine debris; (2) a determination of the recreationist's skill level and the assignment of the appropriate guide personnel; (5) teach bear etiquette, this offers an excellent opportunity-to explain the need to prevent marine debris; (6) training in the use of tide tables, marine charts, and quad maps is essential for kayakers and anglers in order to prevent their equipment from floating away and becoming marine debris; (7) describe the recreation activity's clothing and

equipment, needs; (8) guides describe the region as it is being seen and this communicates a respect for the beauty of the area; (9) guides respond to questions during the recreation activity; (10) guides provide a summary of the trip-and respond to questions at the conclusion of the recreation activity.

Tiedemann, John

Working With Recreational User Groups to Control Marine Debris in the New Jersey Coastal Zone

New Jersey Sea Grant, Sandy Hook, New Jersey, USA

In response to concerns over the impacts of plastics and other debris in the marine environment, the Marine Plastic Pollution Research and Control Act was passed in 1987 to provide for U.S. ratification of MARPOL Annex V, the International Regulations for the Prevention of Pollution by Garbage from Ships. Aside from prohibiting the discharge of plastics in coastal and ocean waters, MARPOL makes it illegal to dump other types of trash in inland waters and ocean waters. In. addition, owners and operators of certain size-classes of vessel must comply with placarding and waste management-plan requirements of the MARPOL regulations. MARPOL also requires ports and terminals, including recreational boating facilities, to provide adequate and convenient garbage reception facilities.

In 1990, the USEPA characterized the types of materials littering the marine environment as generally originating from three potential sources: land-based sources, marine sources, and illegal disposal activities. Marine sources of waterborne debris include commercial maritime activities and waste generated by vessels, including recreational boats. Recreational boating and fishing contribute a variety of wastes to the marine environment, including food packaging, beverage containers, fishing and boating gear like plastic bags, plastic fishing nets, light sticks, floats lures, fishing line, buoys, and metal and wooden traps.

In New Jersey, there are over 150,000 registered recreational vessels and each year approximately 14 million person-hours are spent engaged in recreational boating in coastal waters; There. are also approximately 300-400 party and charter boats operating along the coast. Shoreside boating facilities include approximately 350 commercial marinas and boatyards. These facilities range in size from small commercial fishing docks and small marinas offering. limited services, to extremely large full service marinas.

Although marine debris regulations have existed for a number of years, not all boaters and fishermen are apparently aware of the regulations and their need to comply with them: Studies conducted along the New Jersey coast have confirmed that recreational boating is a source of marine debris and results from recent beach clean-ups indicate that-garbage is still being dumped off of recreational vessels in New Jersey coastal waters.

These facts underscore the need for continuing education about marine debris.

Educating recreational boaters, fishermen, and marina owners and operators about the problems of marine debris and the requirements of Annex V offers an effective means to combat the problem at the source by influencing compliance decisions. Voluntary compliance through education has been shown to be an effective means of achieving the policy objectives of MARPOL during a number of projects conducted at U.S. ports.

In 1991, the New Jersey Sea Grant College Program, working in cooperation with the Center for Marine Conservation, conducted a demonstration project in the Port of Manasquan-Greater Barnegat Bay region of New Jersey that heightened public awareness about the marine debris problem, assisted boaters, anglers, and marina owners and operators in complying with MARPOL Annex V regulations and enlisted their participation in controlling marine debris. Educational methods utilized during the project included radio PSA's, newsletter and magazine articles, posters, brochures, seminars, workshops, and on-site visits.

The NJ Sea Grant Program is extending the results of this demonstration project statewide and responding to other emerging coastal regulations that impact the recreational community by conducting the following education and outreach activities related to marine debris.

- Assisting recreational boaters, fishermen, party and charter boat operators, and marina operators with compliance with MARPOL Annex V by providing placards, fact sheets, sample waste management plans, and other educational materials to them.
- Conducting marine debris seminars and workshops for boaters and anglers at regional and statewide boating and fishing forums and conducting educator workshops about the problems of marine debris and best management practices designed to control marine debris.
- Working with marina and boatyard owners and operators to implement best management practices for solid waste handling in order to control marine debris at their facilities in accordance with applicable federal, state, and local regulations including methods of sources reduction, waste disposal, and designing and establishing recycling programs.

Zilligen, Jil and Barbara Miller

California Marine Debris Action Plan

Center for Marine Conservation, San Francisco, California, USA

Marine debris, ranging from plastic bags, milk jugs, and bleach bottles to tires, fishing line and nets, is more than just a litter problem: it kills marine wildlife, poses a serious health and safety hazard to coastal residents and tourists, and is expensive for coastal communities burdened with repeated cleanup costs.

What sets marine debris apart from other prevailing environmental problems is that immediate solutions exist. Recognizing this fact, the Center for Marine Conservation brought together a diverse coalition of federal, state and local agencies, industry, citizen organizations, scientists, educators and individuals to form the California Marine Debris Steering Committee in 1989. The Steering Committee was charged with. evaluating the marine debris problem, exploring its solutions, and recommending local and state actions to reduce marine debris in California.

After extensively researching the marine debris problem in California, the Steering Committee developed the "California Marine Debris Action Plan." The "Action Plan," printed in June 1990, is divided into three major components: The Problem, The Solution, and Recommended Action. The Problem describes the adverse impact of marine debris and the composition and sources of trash found on California beaches. The Solution outlines what is being done to address the problem. The Recommended Action outlines 22 specific action items recommended by the Steering Committee. The items fall into four general areas of action; enforce laws that reduce marine debris, educate the public, continue research for new solutions, and enact legislation.

Implementation of the "Action Plan" is involving public and private efforts. In the four years since the document was published, much progress has been made, but more work remains to be done. The Center for Marine Conservation and the California Coastal Commission have developed "Save Our Seas," a comprehensive marine debris education program for grades K-12. The Center is also working with the commercial shipping industry to develop a "zero discharge" program in which no solid wastes, except food wastes, will be dumped overboard..

Efforts by other groups to implement the Action Plan's recommendations include:

.Coastal Resources Center conducted a Pilot Port Recycling Project at Pillar Point Harbor. This successful model project, which instituted recycling of plastics and other items', will be replicated in several ports throughout California.

.The California Department of Boating and Waterways is distributing marine debris educational materials to marine retailers, Coast Guard Auxiliaries, and recreational boaters.

.The California Fish and Game Commission hasinserted a paragraph explaining MARPOL Annex V in the state "Angling Regulations," a free publication which lists all California fishing regulations and applicable health notices.

.The California Integrated Waste Management Board has agreed to review waste management in marine areas and offer technical assistance to ports and marinas when necessary.

Zilligen, Jil and Barbara Miller

Save Our Seas Marine Debris Curriculum: Awareness to Action

Center for Marine Conservation, San Francisco, California, USA

The Center for Marine Conservation's Pacific Regional Office, in conjunction with the California Coastal Commission, developed "Save Our Seas," a comprehensive marine debris education program for grades K-12. The education program consists of a new curriculum anthology, a teacher training network, and grassroots events. The program offers both practical approaches to restore the environment, and a tangible first step toward empowering students to become active in their community and world. Students actively learn science concepts and develop an appreciation for the environment, which in turn helps ensure their wise use of our dwindling natural resources. Students personally tackle the problem of marine debris, and have an opportunity to make a difference in solving that problem.

Each unit of the curriculum begins with an activity illustrating the importance of the marine environment and the potential harm caused to this environment by marine debris. Subsequent activities explore specific problems of marine debris in greater detail, and each unit contains a cleanup activity designed to expose students to their environment and the impacts of marine debris first hand. The curriculum bridges the gap between coastal and non-coastal communities with activities such as the cleanup, which can be done at a beach or even in a parking lot or playground, and a storm drain stenciling activity, both of which illustrate the connection between litter on the land and impacts on the marine environment. Additionally, these activities help students realize their potential as involved members of their community.

The teacher training network is led by workshop facilitators, who are educators and environmental professionals trained by Center for Marine Conservation and California Coastal Commission staff to lead marine debris teacher training workshops. In addition to familiarizing teachers with the marine debris curriculum, the workshops expose teachers to a wide range of educational resources and open lines of communication and information exchange between the environmental community and teachers, as well as encourage educators to build partnerships with local agencies.

SESSION V POSTERS

Sources of Marine Debris: Coastal Urban Discharges

Arnold, Gael

Litter Associated With Storm Water Discharges in Auckland City

Centre for Conservation, University of Auckland, Auckland, New Zealand

Storm water debris from commercial, industrial and residential catchments in Auckland City were sampled for one year to estimate the scale of litter discharged from Auckland City into the coastal marine area in this manner.

Three storm water catchments representative of each land use type were selected and debris in the storm water monitored by trapping material in the discharges in 19 mm wire nets placed on the outfall pipes. Debris was collected weekly, categorized as either hard plastic, sheeting and fibers, foam plastic, glass, aluminum, tin/steel, paper/cardboard or other, number of items in each category and the dry weight of each sample was recorded.

Comparison of the number of items associated with land use types showed that industrial areas were a major source (9.69 items Ha^{-1} day^{-1}) followed by commercial (3.33 items Ha^{-1} day^{-1}) and residential areas (1.22 items Ha^{-1} day^{-1}).

Many of the debris items associated with the industrial area sampled were small virgin plastic granules. Comparison of the mass of debris showed the commercial areas were the greatest polluters (3-7g Ha^{-1} day^{-1}) followed by industrial and residential areas (2.42g - 1.46g Ha^{-1} day^{-1}, respectively).

The proportions of each category of debris from storm water were compared with those collected on the beaches of near shore islands in the Haruaki Gulf. Those materials which float and degrade slowly (e.g., hard plastic, foam plastic and sheeting and fibres) were represented in similar proportions in each area. This indicates that storm water may be a significant source of these materials in near shore marine waters, large heavy items such as glass are frequent on near shore islands but hardly found in storm water.

The greatest proportion of storm water debris is paper and cardboard, but this is poorly represented on the islands suggesting that it breaks down in water and does not cause long term marine debris problems.

Bruner, Ronald

Eliminating Plastic Resin Pellets from the Marine Environment.

Society of the Plastics Industry, Washington, D.C., USA

Eliminating the loss of plastic resin pellets into the marine environment is the goal of Operation Clean Sweep, a plastics industry-wide awareness and education program being conducted by The Society of the Plastics Industry, Inc. (SPI). The program is aimed at everyone that manufactures, transports, handles and uses resin pellets.

Resin pellets are the raw material of the plastics industry. They are inert and non-toxic. Plastic pellets. are believed to be a potential hazard, however, if ingested by seabirds and marine life.

Soon after this concern was brought to SPI's attention in 1986, we began briefing resin companies, some of which already had resin containment programs; others have since taken action. Educational materials were produced stressing the message that resin pellets should be contained, reclaimed or disposed of properly.

In 1987, SPI's Board of Directors approved a policy which stated, in part: "SPI is dedicated to working with its member companies to eliminate circumstances that result in resin pellets being lost in manufacturing or transportation and possible rendering harm to animal or marine life that mistake the pellets for food."

In 1991, working with its resin-producing members, SPI developed a Pellet Retention Environmental Code. The major resin companies which signed the voluntary Code have committed themselves to the total containment of plastic pellets throughout the pellets' life span and to operating in full compliance with environmental laws and regulations pertaining to pellet containment. The following year a Processor's Pledge was developed to include those who process resin pellets into products.

Operation Clean Sweep was launched at SPI's triennial international trade show in 1991. It is a multifaceted program to assist the plastics industry at every level to address and solve the problem of resin containment. There are three key components to Operation Clean Sweep:

1. Commitment to the goal of zero pellet loss
2. Changes in behavior and procedures to eliminate or contain spilled pellets
3. Changes in equipment and facilities to eliminate or contain spilled pellets.

Operation Clean Sweep supports companies with a comprehensive educational program to help them inform and motivate employees and identify and remedy problems in behavior, procedures, equipment and facilities that cause pellet loss into the environment. More than 20,000 copies of materials have been distributed to plastic companies in the United States and abroad since the program was launched. Operation Clean Sweep stresses

teamwork. Senior management must set the tone. But the men and women who work on the floor, on the docks, in the warehouses, driving the trucks and forklifts, making the connections, taking the samples and packing the bags -- they all must be involved in finding solutions and improving the way our industry operates.

SPI's commitment to the environment extends beyond resin pellets. In its 1987 policy statement, our Board of Directors said: "The SPI supports the responsible use of its industry's materials and proper disposal of those products when they become waste. Plastics should not be discarded into the ocean or any other body of water."

In support of this policy, SPI has:
- Testified before Congress in support of Annex V of the MARPOL Convention
- Supported financially and otherwise major domestic and international beach clean-ups (as have a number of member companies)
- Developed an ongoing public information campaign about the proper disposal of plastics in cooperation with the Center for Marine Conservation (CMC) and the National Oceanic and Atmospheric Administration (NOAA)
- Cooperated with the U.S. Environmental Protection Agency in the research and preparation of the report "Plastic Pellets In The Aquatic Environment: Sources and Recommendations."
- We also are pleased to be a sponsor of the Third International Conference on Marine Debris.

Durrum, Emmet

Floating Debris in the Anacostia River

District of Columbia Department of Public Works, Washington, DC, USA

This poster describes a pilot project undertaken to control floating debris on the tidal Anacostia River. Besides being unsightly, floating debris limits spawning areas and habitat for fish and benthic organisms and disrupts aquatic vegetation that stabilizes shorelines and wetlands. Floating debris interferes with recreational boating and fishing. Left unchecked, floating debris from the Anacostia Basin ultimately reaches and degrades habitat in the Chesapeake Bay and the open Atlantic.

The abatement project was designed to address debris control problems intrinsic to the Anacostia River, i.e., strong tidal influence, relatively low flow rate, many combined sewer outfalls (CSOs), long turnover time (up to 90 days), and many mudflats and deltas exposed at low tides.

This paper describes the project, its objectives, methodologies, and results. The main objectives were to identify the sources, the type, and the quantity of floating debris; test methods and equipment for controlling floating debris; document methods and results for use in other jurisdictions with floating debris problems in similar urban stream systems;-and use the experience

gained during this USEPA funded pilot study to establish a long-term floating debris control operation for all District waterways.

The pilot program has had a visible effect on reducing floating debris on the tidal Anacostia River. The testing and evaluation of various floating debris control measures, equipment, and personnel deployment strategies demonstrated the most practical and cost-effective, means of controlling floating debris on the river.

The obvious, effectiveness of the project was the impetus behind the establishment and funding of a permanent floating debris control program for District of Columbia waterways in March, 1993.

Halperin, Laurie

Million Points of Blight Network

Center for Marine Conservation, Hampton, Virginia, USA

Non-point source pollution, or "pointless" pollution, originates from many different places. Some of this pollution is created when rain washes pollutants such as cigarette butts, street litter, pet wastes, oil and grease, and excess fertilizers and pesticides, down storm drains., Other types of non-point source pollution are caused by various land-use practices, including farming, timber harvesting, mining, and construction. The Environmental Protection Agency has determined that non-point source pollution is a leading cause of our nation's water quality problems.

In November 1990, the EPA issued a final rule to implement Section 402(p) of the Clean Water Act, federal legislation aimed at preserving the quality of America's waters. This final rule requires cities with populations greater than 100,000 that have separate storm sewer systems to obtain a National Pollution Discharge Elimination System (NPDES) permit. A main component of. this storm water law is to educate the public about storm water run-off and non-point source pollution and what they can do to help reduce it. For this reason, many cities have become interested in storm drain stenciling to help them comply with these regulations.

The Center for Marine Conservation's national Million Points of Blight storm drain stenciling campaign alerts people to a problem that they can correct through responsible behavior. Many people don't realize that the. storm drains in their neighborhoods are direct links to nearby streams and rivers,. and ultimately, the ocean. The goal of Million Points of Blight is to educate the public, both- in coastal and inland states, about this direct connection between storm drains and local waterways. With help from volunteers, one million storm drains across the country will be stenciled with clean water messages such as "Don't Dump, Drains to Waterway" to help make that connection.

Million Points of Blight serves as a national network for established storm drain stenciling programs run by state and local government, as well as several non-governmental groups. Storm drain stenciling is not a new idea; in fact some organizations have been conducting such projects for years, but the Center believed that it would be helpful for these groups to become part of a network to share ideas and success stories. In addition, Million Points of Blight serves as a guide for individuals and groups which do not have storm drain stenciling programs in their areas. The Center provides educational materials on non-point source pollution and stencils to those who want to get stenciling started in their communities.

There are currently 89 on-going stenciling projects in 32 U.S. states and Canadian provinces that are part of the Million Points of Blight network, with documentation of over 100,000 drains stencilled.

SESSION VI POSTERS

Sources of Marine Debris: Rural, Coastal and Upland Discharges

Baird, David

Clean Islands International Caribbean Project

Clean Islands International, St. John, New Brunswick, Canada

Element 1: It is proposed to establish a detailed scientific study of beach debris in the wider Caribbean, consistent with the procedures developed for other projects. This would be similar to the Marine Debris Pilot Monitoring Project, carried out by the University of Puerto Rico and those being developed by the EPA for the U.S. coastal beach debris sampling program. That is, sampling transects of specific target beaches are done on a monthly basis. In the Wider Caribbean, we would be starting with a series of target beaches (in the order of 12) scattered throughout the region. A detailed consideration would be given to actual site selection for the long term study.

Element 2: Once the study in Element 1 is well established, we will expand the scope of the study area to eventually encompass every country in the region. It is expected that the research project will span five years to a full implementation in all 29 countries. Implementation plans will allow for the monitoring process to carry on for a further period beyond that time.

Methodology: The actual sampling program will be started by the team above, in the company of local individuals or groups, such as a school or college class (depending on the specific island or community). These people would be trained in the methodology to be used for the project duration, as they will take stewardship of the continued-data acquisition. The project scientists would carry out periodic follow up monitoring with the local groups, to ensure consistency.

Element 3: To be developed concurrently with the scientific research, above, will be an educational outreach program for each country involved. Discussions would be held with the educators of each country, to develop a sense of, and a sensitivity to, their educational needs in our development of a Marine Debris and Solid Waste Curriculum for the Wider Caribbean Region. The framework would also be established for the development of teacher in-service workshops, and the customization of the curriculum to each country as required. This too, would be a staged implementation, requiring about seven years to fully implement in all 29 countries.

Element 4: As an extension to Elements 1 and 2, the research team should develop a computer data base for the. beach debris data collected. This computer system would provide for the establishment of a telecommunications link to the data base and for the addition of data acquired by-others. Further, linkage of information to an -electronic atlas are to be explored as part of this project.

Baird, David

Sources of Beach Debris: Great Guana Cay Abaco; the Bahamas

Clean Islands International, St. John, New Brunswick, Canada

In April 1992, a dozen environmentalists and solid waste professionals gathered on the island of Great Guana Cay, a ten kilometer long barrier island on the northeastern edge of The Bahamas. Their purpose was to work on a number of issues ranging from alternatives for an impending dump closure to a Center for Marine Conservation documented beach clean up. Several community awareness and school education projects were incorporated into the week's activities.

Follow-up visits were made to this island in October 1992 and April 1993, where among the activities, additional documented beach cleanups were carried out. Although not a true scientific study, there are some empirical views on the origins of beach debris at this location. The main beach faces northeast, onto the open Atlantic Ocean, exposed only to open ocean currents. The harbor beaches, along the southwest-side of the island front on the more or less enclosed Sea of Abaco.

In the documentation, we observed a significant reduction in debris encountered after the first. clean up, indicating. primarily, a long term accumulation on the -ocean beach. The harbor beach saw a major sustained reduction purely as a result of local awareness. The residents stopped throwing old boat motors into the harbor, and hired a caretaker to groom the beach of incidental litter. The school children placed litter containers through out the community and along the path to the ocean beach, thus capturing that which might otherwise become eventually marine debris.

Our poster display describes the work that the Clean Islands International has carried out on Great Guana Cay. Included are photographs and relevant documentation.

Bormanis, Peter and Inara Briede

Some Aspects of Water Pollution in the Riga Gulf and the Baltic Sea

Keep Latvia Tidy Foundation, Jurmala, Latvia

In this paper, the Keep Latvia Tidy Foundation analyzes not only traditional and civilian sources of marine debris (agriculture, industrial waters, vessels, etc.), but also the rarely mentioned marine debris of military origin (poisonous weapons sunk at sea; sea artillery and rocket polygons; after-effects of ignition bombs blasted at sea, etc.).. Amber searchers, particularly children, are frequently burned after picking up phosphorous materials that resemble amber. These incidents occur along the Latvian coastline which stretches for 500 kilometers along the Baltic Sea. The coastline is undisturbed, with unspoiled habitat that few Western countries can imagine. These areas were off

limits during the Soviet Union era. Latvian sea waters and shores are therefore a perfect place for wildlife, recreation and tourism. Other items in our poster include:

1) General information about the activities of the non-government organizations (NGOIs) connected with marine debris problems (namely, Coalition Clean Baltic Riga Branch, Environmental Protection Club of Latvia and Keep Latvia Tidy Foundation);
2) Geographical peculiarities and other characteristics of the Gulf of Rigas;
3) Main sources of marine debris in Latvian waters;
4) Practical work and results of the NGO network in Latvia.

Hall, Martin, Marco Garcia, Alejandro Pares-Sierra, and Pablo Arenas

The Use of a Drift Model to Simulate Trajectories of Floating Objects and Marine Debris Entering the Coastal Areas of the Eastern Pacific Ocean

Inter-American Tropical Tuna Commission, San Diego, California, USA

A 1.5 reduced-gravity, non-linear model was used to obtain the underlying ocean currents of the Equatorial Pacific Ocean. the model was forced using realistic values of wind speed and direction obtained from the Comprehensive Ocean-Atmospheric Data Set (COADS). The model equations were integrated from 1971 to 1987 to obtain monthly matrices of current vectors and thickness of the upper layer. These matrices were the input of a Lagrangian simulation model used to predict and analyze the trajectories of floating objects entering the eastern Pacific Ocean through five selected locations near the mouths of major rivers of the region.

The aspects studied for each location included (1) direction, velocity and other characteristics of the trajectories of objects entering the location's vicinity; (2) the influence of the origin of the object on its final destination; (3) seasonal variation (especially in relations to precipitation patterns) and annual variation (with emphasis on the impact of El Nino events) in the trajectories of objects with a common origin.

The main conclusions are that:
1) Through either cyclic current patterns or oscillating north-south movements, most objects are retained relatively close to their source for considerable periods;
2) Practically all the transport offshore occurs along l0^{o}N corridor;
3) El Nino events alter the patterns substantially, increasing the velocity of the offshore movements of the objects, but always along the l0^{o}N corridor.

There are many other potential uses for the drift trajectories, among them, studies of biological, geographic and chemical cycles involving the floating objects, distribution of marine debris,

distribution of juveniles of marine organisms such as sea turtles, and regional and transoceanic dispersal of pollutants and larvae.

MacDonald, Lynne, Ralf Boulon, and Julie Wright

The U.S. Virgin Islands Clean Roads -- Clean Reefs Campaign, A Multi-Agency Approach to Addressing Marine Debris

University of the Virgin Islands, Marine Advisory Service, St. Thomas, U.S. Virgin Islands

Educational efforts that address marine debris in the United States Virgin Islands, as in all coastal and insular areas, must target a number of diverse audiences. Some of the prominent marine resource user-groups include: beach-goers and picnickers, commercial and recreational boaters and fishers, and shipping/transportation interests. In order to effectively address all of these "target-audiences a number of agencies and organizations in the Territory have joined forces to develop the marine debris educational program "Clean Roads -- Clean Reefs"; a program adapted from the U.S. Environmenta. Protection Agency Region 2 "Clean Streets/Clean Beaches" campaign. This collaborative effort by the University of the Virgin Islands' Marine-Advisory Service (VIMAS) and Cooperative Extension Service (CES), the Government of the U.S. Virgin Islands (Department of Planning and Natural Resources' Division of Fish and Wildlife (DFW), Public Works Department (DPW) and the Department of Education's Environmental Studies Program (ESP)) allows each agency to work with the user-group(s) with whom it has established relationships to build more "personalized" programs upon, each target-audience is more receptive to the campaign's 'message." At the same time this approach allows program-, material-. and information-sharing among their participating agencies, thereby preventing/reducing redundant efforts in program development. This increased efficiency in program development allows efforts to be directed with greater effectiveness and to a broader audience than a solitary effort by any individual agency could achieve.

This poster presentation illustrates the various materials used by each agency in the Clean Roads -- Clean Reefs campaign to address specific audiences. It also highlights the campaign's common theme that marine debris is aesthetically, economically, and environmentally harmful, as well as threatening to human health.

The Virgin Islands Clean Roads -- Clean Reefs Campaign is funded, in part, by the U.S. Environmental protection Agency Region 2, the Professional Association of Dive Instructors (PADI), and Maho Bay Campgrounds, Inc., St. John, USVI.

O'Hara, Kathy

Marine Debris Outreach Campaign in the Wider Caribbean

Center for Marine Conservation, Hampton, Virginia, USA

During an 11-month study in 1993, the Center for Marine Conservation surveyed individuals in 29 countries in the Wider Caribbean about the problem of litter on beaches, and the sources of that litter. A report entitled, Marine Debris Outreach Campaign in the Wider Caribbean, prepared for the United Nations, has been published.
Based on interviews, literature searches, on-site visits, and data collected during volunteer beach cleanups, both land-based and ocean sources of coastal litter were identified as contributing to the problem of marine debris.

This display features examples of upland discharges of litter that eventually become marine debris. Sources of this debris include littering by the general public, runoff from streets and rivers, beach visitors, open dump sites, coastal dumping, and inadequate sewage treatment systems.

In the Caribbean, each island nation suffers from trash improperly disposed of by a neighboring island. The term "trash trading" indicates that what starts out as litter from an upland source, can, due to rains, and winds, eventually reach the sea, and float to the shores of another island. Thus upland trash from one island often becomes a coastal problem for another island.

Improper solid waste disposal practices have negative effects on coastal areas. These include, destruction of aesthetic beauty, injury to beach visitors, negative impacts on tourism and loss of income from tourism, cleanup expenses, destruction of marine ecosystems, harm to coastal and marine wildlife.

Education programs about solid waste issues and marine debris should be directed to both the local population as well as visitors. The general public should be informed about proper disposal of plastic food packaging, and domestic household wastes.

A successful campaign will involve local people in the planning of educational materials, be island specific, and be multilingual. The International Coastal Cleanup, with data collection, is cited as an education, community based project that is hands-on in nature, and helps to solve the litter problem from offshore and land-based sources.

The Center's outreach plan includes working with specific sources of debris, holding workshops, and developing public service announcements. Phase II includes establishing a monitoring program on debris and seven other community based activities. The campaign helps residents, visitors, and the international community realize the need to eliminate marine debris from the waters of the Wider Caribbean.

Sweeney, Vincent D.

Pollution of Castries Harbour, St. Lucia, West Indies.

Caribbean Environmental Health Institute, Castries, St. Lucia

The city of Castries is the capital of St. Lucia, an island of approximately 238 square miles located in the Eastern, Caribbean. The population of Castries is approximately 60,000, almost 50% of the island's total population of 140,000. This densely populated city is characterized by many of the problems typical of small island developing states, such as poor liquid and solid waste management systems.

Castries Harbour, renowned for being one of the most picturesque harbours in the Caribbean, suffers from severe pollution problems from a variety of sources, including port related activities, sewage and, most notably, the Castries River. The Castries River, which empties into the harbour, can be transformed by a downpour of rain from a trickle to a raging torrent. This phenomenon, combined with the practice by many of the residents of the city of disposing of their domestic waste into the "nearest gully" (usually a tributary to the Castries River), results in large volumes of solid waste being deposited in the harbour. Much of the waste includes floatable debris which does not make its way out to sea, but accumulates, instead, in the many inlets of the harbour, creating an unsightly and potentially hazardous nuisance.

Although part of the problem can be attributed to the poor solid waste collection system in Castries, a major cause can be the lack of public awareness related to pollution and also the attitude of many persons that "it is okay to dump in the drains. and ravines since after it rains the problem is gone away." A major challenge facing St. Lucia, and much of the Wider Caribbean, is to educate the general public on the ills of pollution, from indiscriminate dumping and otherwise, starting at the primary/elementary school level and using the widest possible media exposure. It is clear that unless attitudes change, technical approaches will have limited success.

POSTER MANUSCRIPTS

THIRD INTERNATIONAL CONFERENCE ON MARINE DEBRIS

Miami, Florida, USA

May 8-13, 1994

SESSION I POSTER MANUSCRIPTS

Amounts, Types and Distribution of Marine Debris

Baba, Norihisa and Masashi Kiyota

Distribution and Characteristics of Marine Debris in the North Pacific Ocean, 1989-1990

National Research Institute of Far Seas Fisheries, Fisheries Agency, Shimizu, Japan

Abstract

Distribution and characteristics of marine debris in the North Pacific and in the Bering Sea were studied using sighting data collected at 77 daily transect lines from June to August in 1989 and 1990. Total distance surveyed was 17,125 km and the sighting area was a total of 6,850 km^2. Petrochemical products (e.g., nylon, Styrofoam, vinyl, polyethylene goods etc.), composed 76.2% of the total of 3,440 pieces of debris sighted. Other debris consisted of glass (3.2%), metal (1.3%), wood (10.7%) and natural log (8.6%). Fishing debris accounted for 18.3% of the total petrochemical debris; gillnet floats alone accounted for 15.0% of the total petrochemical debris. 'Fishing net fragments were minor components of the total of marine debris observed. They were observed mainly in the central North Pacific. Density (number/km^2) of marine debris was high in the coastal areas off northern Japan and off North America, and low in the Bering. Sea, offshore areas off Alaska, Kamchatka, and Kurile Islands. The highest densities of marine debris occurred in the central North Pacific northeast of the Hawaiian Islands. These data, suggest that marine debris in the North Pacific may be concentrated in the northeastern area off Hawaii by a large gyre current.

Introduction

Convenient goods, such as plastic, vinyl, Styrofoam etc., have been created as human life developed, and these manmade products, have been accumulating in the ocean. Many surveys and education programs on marine debris have been conducted and their results were reported at the 1st and 2nd Marine Debris Conferences held in Hawaii in 1984 and 1989, respectively. Mio et al. conducted a sighting survey of marine debris in the North Pacific and reported that density of marine debris was high in the coastal area of land and in the area between 25°N-30°N and 170°W-13O°W. Furthermore, Day et al. reported that highest density of marine debris generally occurred in the Japan Sea and near shore Japan Water, Transitional Water, and Subtropical Water. Matsumura et al. estimated that floating debris may gather in the eastern and western regions of the mid-Pacific, though nobody surveyed those places. Objectives of this study were to study the distribution and characteristics of marine debris in the North Pacific and Bering Sea, and to confirm whether or not marine debris in the North Pacific gathers in the northeastern area off Hawaii.

Materials and Methods

We conducted sighting surveys of marine debris from June 4 to August 9 in 1989 and from June 2 to August 4 in 1990 in the North Pacific and Bering Sea. In 1989, the research vessel cruised off northern Japan, along the 40°N line from 160°E to 16O°W; thence south along the 160°W line from 40°N to Hawaii; thence along 30°N from 160°W to 130°W off California; thence to the Gulf of Alaska, near shore off the Aleutian Islands, the Bering Sea, off Kamchatka and Kurile Islands, and returned to Japan (Fig. 1). In 1990, vessel cruised almost the same track-as 1989 except along about the 47°N line from 160°E to 130°W (Fig. 2).

Sightings were conducted by one or two persons from sunrise to sunset from the flying bridge (pilot house in rain). Binoculars were used only to confirm kind and number of debris. When visibility was less than about 300 m; the survey was interrupted but vessel continued to cruise. Cruising speed was about 10 knot while sighting. Observers rotated every hour between the flying bridge and pilot house.

When debris was observed, time, location, number, size, type of debris, and distance from vessel to debris were recorded. Ship's position, weather, wind direction, wind force, air temperature; and surface water temperature were recorded every hour while cruising. Types of debris were categorized as fishing net fragments, other fishing debris except fishing net, plastic (nylon, vinyl, polyethylene etc.), Styrofoam, glass goods; metal goods, wood, natural log, and others. Debris was recorded as a code (Mio and Takehama, 1987).

Sighting data were analyzed by sea regions, off northern Japan, low (about 40°N line) and high (about 47°N line) in the western North Pacific, central North Pacific (about 160°W line from 40°N to Hawaii), low (about 30°N line) and, high (about 47°N line) in the eastern North Pacific, off California, in the Gulf of Alaska, near shore of Aleutian Islands and Bering Sea, and off Kamchatka and Kurile Islands. Sighting width of observer (200 m) was estimated by number of pieces of-debris per perpendicular distance (Fig.3). Research area was calculated multiplying the sighting width by research distance.

Results

Amount of marine debris

3,440 pieces of debris were observed in a total distance of 17,125.l km during the whole research periods. Number of pieces of debris per l km research distance was 0.20 fragments through the entire research period. The type of most abundant debris was petrochemical products (nylon, Styrofoam, vinyl, polyethylene goods etc.), which composed 76.2% of the total of 3,440 debris sighted. Other. debris consisted of glass (3.2%), metal (1.3%), wood (10.7%) and natural log (8.6%) (Table 1). Plastic debris in petrochemical products except Styrofoam occupied 43% of the total 3,440 debris sighted and styrofoam was 20% (Fig. 4).

Fishing debris accounted for 18.3% of the petrochemical debris; gillnet floats alone comprised 15.0% of the total petrochemical debris. Fishing net fragments (35 trawl net fragments, 27 gillnet fragments, 3 unknown net fragments) were minor components of the total petrochemical debris observed (Fig. 5). As the results of collecting the fishing net fragments, weight of two fishing net fragments were more than several hundred kilograms. They consisted of many kinds of trawl nets, gillnet, ropes, and other strings, and those fragments were bound (Photo 1). Fishing net fragments were mainly observed from June 24 to 30 in 1989 while cruising in the central North Pacific (Fig. 6).

Density of marine debris

Density (number/km^2) of marine debris was high in the center of North Pacific (about 160°W line from 40°N to Hawaii, l.0/km^2) and off North America (0.6/km^2). It was low in the Bering Sea. offshore area off Alaska, Kamchatka and Kurile Islands (under 0.2/km2). The highest densities of marine debris occurred in the northeastern area off Hawaii (1.4/km^2) and the coastal area off northern Japan (1.3/km^2). Distribution of plastic debris density were similar to that of total debris density except off California (Table 2).

Distribution characteristics of marine debris

Percentages of marine debris observed in the North Pacific and Bering Sea are shown in Table 3. Percentage of wood and natural log were higher than 14.4% in the Bering Sea, offshore area off Alaska, Aleutian Islands, Kamchatka, and Kurile Islands except high latitude (47°N line) of western North Pacific (53.1%). On the other hand, percentage of petrochemical products were higher than 82.1% off northern Japan, central North Pacific, and in the north eastern area off Hawaii and low, less than 46.7%, off California, Alaska Bay, Aleutian Islands, Bering Sea, off Kamchatka, and Kurile Islands.

Discussion

Distribution of total density of marine debris in this study was similar to results of Mio et al. and Day et al. Density of wood and natural log were higher in the north area and lower in the middle area of North Pacific. On the contrary, density of petrochemical products was higher in the middle area and lower in the north area of North Pacific. This result may be related to human population and number of towns.

Matsumura et al. reported that marine debris in the North Pacific may accumulate in the northeastern area off Hawaii. Density of marine debris was highest off northern Japan and in the north-eastern area off Hawaii. This tendency was shown on change of daily number of Styrofoam, vinyl, polyethylene, plastic observed in 1989's survey (Fig. 7) and 1990's survey (Fig. 8). Furthermore, many fishing net fragments were observed in the northeastern area off Hawaii. Kuroshio extension flows to the central North Pacific (Favorite et al. 1976) Matsumura et al. indicated that a large gyre current exists in northeast area off Hawaii. The northeastern area off Hawaii is recognized as an

accumulation place of marine debris in the North Pacific. Marine debris gathered in this area may be difficult to get out. It is necessary to clean up the debris, especially large debris and dangerous debris for ships, such as huge fishing net fragments, in this area. We collected about 30 fishing net fragments in this area in 1989. Clean up is considered to be possible.

Acknowledgements

We thank the crew of R/V Shunyo-maru for cooperation of research activity.

Citations

Day, R. H., D. G. Shaw, and S. E. Ignell. 1990. The quantitative distribution and characteristics of marine debris in the North Pacific Ocean, 1984-88. In R.S. Shomura and M.L. Godfrey (eds.) Proceedings of the Second International Conference on Marine Debris, p.182-211, 2-7 April 1989, Honolulu, Hawaii. U.S. Dep. Commer., NOAA Tech. Memo. F/SWFSC-154.

Favorite, F., A. J. Dodimead, and K. Nasu. 1976. Oceanography of the subarctic Pacific region, 1960-71. Int. North Pac. Fish. Comm. Bull. 33:1-187.

Matsumura, S., Y. Wakata, and Y. Sugimori. 1990. Movements of floating debris in the North Pacific. Tn R.S. Shomura and M.L. Godfrey (eds.), Proceedings of the Second International Conference on Marine Debris, p.267-278, 2-7 April 1989, Honolulu, Hawaii. U.S. Dep. Commer., NOAA Tech. Memo. F/SWFSC-154.

Mio, S., and S. Takahama. 1987. Distribution of marine debris based on sighting survey in 1986. Document submitted to the Thirty-fourth Annual Meeting of the Int. North Pac. Fish. Comm.

Mio, S., S. Takehama,, and S. Matsumura. 1990. Distribution and density of floating objects in the North Pacific based on 1987 sighting survey. In R.S. Shomura and M.L. Godfrey (eds.), Proceedings of the Second International Conference on Marine Debris, p.212-246, 2-7 April 1989, Honolulu, Hawaii. U.S. Dep. Commer., NOAA.Tech. Memo. F/SWFSC-154.

Table 1. Outline of sighting survey of marine debris in the North Pacific and Bering Sea in 1989 and 1990.

Period	Distance (km)	Number of Debris Sightings					
		Plastics	Glass	Metal	Wood	Logs	Total
6/4-8/6/89	10,342.7	2,134	89	28	208	117	2,576
6/2-8/4/90	6,782.4	488	20	16	161	179	864
Total	17,125.1	2,622	109	44	369	296	3,440
		76.2%	3.2%	1.3%	10.7%	8.6%	100%

Table 2. Densities (number/km^2) of general types of marine debris in the North Pacific and Bering Sea from June to August in 1989 and 1990.

Parameter	No. Japan	North Pacific				
		West		Central N. Pacific Center	East	
		W-Low	W-Hi		E-Low	E-Hi
Total Debris	1085	185	94	492	799	28
Distance (km)	2129.8	2170.5	1305.7	1227.9	1383.4	953.8
Area (km^2)	851.9	868.2	522.3	491.2	553.4	381.5
Tot. Density	1.3	0.2	0.2	1.0	1.4	0.1
Plastics	1.0	0.2	0.0	0.9	1.4	0.1
Glass	0.0	0.0	0.0	0.1	0.0	0.0
Metal	0.0	0.0	0.0	0.0	0.0	0.0
Wood	0.1	0.0	0.1	0.0	0.0	0.0
Logs	0.1	0.0	0.1	0.0	0.0	0.0

Parameter	North Pacific			Bering Sea and Aleutians
	California	Gulf of Alaska	Kamchatka/ Kurile Is.	
Total Debris	328	174	78	177
Distance (km)	1389.0	2018.7	1807.6	2739.1
Area (km^2)	555.6	807.5	723.0	1095.6
Tot. Density	0.6	0.2	0.1	0.2
Plastics	0.3	0.1	0.0	0.1
Glass	0.0	0.0	0.0	0.0
Metal	0.0	0.0	0.0	0.0
Wood	0.1	0.0	0.0	0.0
Logs	0.2	0.1	0.0	0.0

W-Low: Low latitude area of western North Pacific surveyed 6/89.
E-Low: Low latitude area of eastern North Pacific surveyed 6/89.
W-Hi: High latitude area of western North Pacific surveyed 6/90.
E-Hi: High latitude area of eastern North Pacific surveyed 6/90.
Plastics: Nylon, vinyl, styrofoam, plastic, fishing gear.

Table 3. Percentage of marine debris in the North Pacific and Bering Sea from June to August in 1989 and 1990.

Parameter	North Pacific						Bering Sea
	No. Japan	West		Central N. Pacific Center		East	
		W-Low	W-Hi		E-Low	E-Hi	
Total Debris	1085	185	94	492	799	28	
Plastics	82.1	85.3	24.4	88.8	94.2	85.7	
Glass	2.7	2.7	3.2	5.7	3.1	0.0	
Metal	1.4	0.5	3.2	1.0	0.4	3.6	
Wood	9.7	10.3	35.1	4.3	2.3	7.1	
Logs	4.1	1.1	34.0	0.2	0.1	3.6	

Parameter	North Pacific			Bering Sea
	California	Gulf of Alaska	Kamchatka/ Kurile Is.	and Aleutians
Total Debris	328	174	78	177
Plastics	46.7	45.4	29.4	46.4
Glass	2.4	1.7	3.8	2.8
Metal	0.9	4.6	1.3	2.3
Wood	22.6	14.4	37.2	24.3
Logs	27.4	33.9	28.2	24.3

W-Low: Low latitude area of western North Pacific surveyed 6/89.
E-Low: Low latitude area of eastern North Pacific surveyed 6/89.
W-Hi: High latitude area of western North Pacific surveyed 6/90.
E-Hi: High latitude area of eastern North Pacific surveyed 6/90.
Plastics: Nylon, vinyl, styrofoam, plastic, fishing gear.

SESSION II POSTER MANUSCRIPTS

Impacts of Marine Debris

Baba, Norihisa

Characteristics of Northern Fur Seals Callorhinus ursinus Entangled in Marine Debris in the Western North Pacific Ocean and Okhotsk Sea from 1971 to 1987 and 1993

National Research Institute of Far Seas Fisheries, Shizuoka, Japan

Abstract

22 (5 males, 17 females) northern fur seals entangled in marine debris were observed in a total research distance of 69,164 km in the western North Pacific and Okhotsk Sea during 1971-1983 and 1993. Discovery rate of entangled fur seals were 0.09 to 1.21 seals per 1,000 km (mean ; 0.32). Entanglement rates (percentage of entangled seals / total observed seals) were 0.01 to 0.23% (mean 0.06%). Kinds of debris entangled on fur seals were fishing net fragments, plastic packing bands and cord. Fishing net fragments accounted for 67% of total debris. Entangled male seals were 1, 2, and 5 years old and females were 2 to 23 years old. Juvenile fur seals entangled in marine debris were more numerous than adults.

Introduction

Northern fur seals, Callorhinus ursinus, were separated roughly into two groups. One was fur seals bred at Pribilof Islands, Bogoslof Island, and San Miguel Island, and they migrated mainly along the continental shelf in the eastern North Pacific. The other one was fur seals bred at Commander Islands, Kurile Islands, and Robben Island, and they migrated mainly along the islands in the eastern North Pacific (Kajimura and Loughlin). Data on Pribilof fur seals entanglement have been collected actively at St. Paul Island since the 1960's, in the eastern Bering Sea and central North Pacific (Scordino, Fowler, Fowler et al., Dahlberg and Day, Baba et al.). Fowler summarized that the entanglement rate of juvenile male fur seals at St. Paul Island was 0.3-0.4%, that 0.2-3.1 trawl net fragments were sighted per 1,000 km research distance and that l0-17% of these fragments were observed to contain entangled seals. There are few reports about entanglement of fur seals on Robben Island, Commander Islands, and Kurile Islands in the literature (Kuzin, Yoshida and Baba).

Ribic and Swartzman indicated that data of distribution on oceanic debris and fur seals are needed to evaluate the impact of entanglement on fur seals. To understand the status of entanglement on northern fur seals in the North Pacific, information of entanglement on fur seals in the western North Pacific are necessary. The purpose of this paper is to determine the entanglement rate of fur seals in the western North Pacific and

better understand the biological characteristics of entangled fur seals.

Materials and Methods

I analyzed sighting and biological data on northern fur seals collected by the pelagic research activities conducted under the Interim Convention on Conservation of North Pacific Fur Seals. (NPFSC, before 1984) and under the permit of Fisheries Agency, Japanese Government (1985 and after) in the western North Pacific and Okhotsk Sea from 1971 to 1987 and 1993. Research track is shown in Figure 1.

Sightings were conducted by one or two persons from sunrise to sunset from the flying bridge (pilot house in rain). Binoculars were used only to confirm species and number of animals. When visibility dropped to less than about 300 m or beaufort scale over 3, the survey was interrupted.

Entangled-fur seals were collected, the body lengths and weights were measured and upper canines, stomachs, and reproductive organs collected. The upper canines were frozen and stomachs and reproductive organs were kept in 10% formalin. Age of fur seals was determined from annual layers on dentine of canines (Scheffer). Location of ship, weather, wind direction, wind force, air temperature and water temperature etc., were observed every hour during research.

Results

Entanglement rate of fur seals at sea

36,218 fur seals were observed in a total research distance of 69,164.l km in the western North Pacific and Okhotsk Sea during 1971-1987 and 1993. Of them, 22 fur seals were entangled. in, marine debris. Discovery rate of entangled fur seals per year were from 0.09 to 1.21 seals/l,000 km with a mean of 0.32 seals/l,000 km. Entanglement rates (number of entangled seals / total observed seals) per year varied from 0.01% to 0.23% with a mean of 0.06% during whole research periods (Table 1). Entanglement rate increased from 1971 and attained the peak during 1975-1976 and decreased gradually to 1987. It increased again in 1993 (Fig. 2).

Kinds of entanglement debris

Of the 22 entangled fur seals, one was net-marked (without debris) and 21 were actually entangled with debris. Of 21 seals with debris, 17 were entangled in fishing net fragments (67%), 3 in plastic packing bands (14%) and 3 in cord (14%). Fishing net fragments entangled on male seals accounted for 60% of total males, and 70% of total females (Fig. 3). Size and weight of debris were not always recorded-. Weights of two trawl net fragments entangled on fur seals were 230 g and 500 g in air, respectively. Whole length of one plastic packing band was 73 cm (Table 2). One seal had a scar at the neck caused by fishing net fragments.

Characteristics of entangled fur seals

Of the 22 entangled fur seals, five were males (23%) and 17 were females (77%) (Table 2). Males entangled in debris were 1, 2 and 5 years old. 2-year old males accounted for 60% of the total. Females entangled in debris were from 2 to 23 years old. 2-to-4-year olds accounted for 47% of total females. Two female seals entangled in plastic packing bands were pregnant. Mean age of both male and female fur seals entangled in debris was younger than that of total seals collected for biological study under the NPFSC (Fig. 4).

Discussion

Entanglement rate (0.06%) of fur seals including male and female in the western North Pacific in this study was similar to that (0.07%) in the eastern Bering Sea surveyed during 1984-1985 and 1988 (Baba et al.). Entanglement rate at sea in this study was between entanglement rate on Robben Island (0.03-2.19%) and Commander Islands (0.05-1.15%) (Kuzin). Although the entanglement rate of fur seals at sea tends to be smaller than that on land, it may be due to the small researched area and missed observation of entangled seals at sea. Furthermore, entanglement rate of fur seals at sea was low level in comparison with female entanglement rate on St. Paul Island (0.15%, DeLong et al.) and juvenile male entanglement rate at St. Paul Island (0.3-0.4%, Fowler), Robben Island (0.83-4.20%) and Commander Islands (0.5202.46%) (Kuzin).

Discovery rate (0.32 seals/l,000 km) of entangled fur seals in the western North Pacific in this study was about twice that (0.14) in the eastern Bering Sea (Baba et al.). Fishing net fragments are dominant in all debris entangled on fur seals, and this tendency was similar to entanglements at Pribilof Islands, Robben Island and Commander Islands (Fowler, Kuzin). It may be because the number of fishing vessels in the western North Pacific is greater than in the eastern Bering Sea.

Two of 22 entangled seals were decayed and drifted at sea. The facts indicate that entangled fur seals-die at sea. Male seals entangled in debris were 1 to 5 years old. Females were 2 to 23 years old. Many young seals under age 4 were entangled. Yoshida et al. reported that young fur seals are apt to entangle more than adult seals owing to curiosity of the floating materials. Although fur seals of various ages may become entangled in marine debris, I am afraid that entanglement of young fur seals affects the population.

Acknowledgements

I thank Drs. Kazumoto Yoshida and Naoto Okumato for conducting the pelagic survey and collecting the sighting data and samples of fur seals. I thank the crew of the research vessel for their cooperation in the fur seal research activity.

Citations

Baba, N., M. Kiyota, and K. Yoshida. 1990. Distribution of marine debris and northern fur seals in the western Bering Sea. In R.S. Shomura and M.L. Godfrey (eds.), Proceedings of the Second International Conference on Marine Debris, p. 419-430, 2-7 April 1989; Honolulu, Hawaii. U.S. Dep. Commer., NOAA Tech. Memo. F/SWFSC-154.

Dahlberg, M. L., and R. H. Day. 1985. Observations of manmade objects on the surface of the North Pacific Ocean. In R.S.Shomura and H.O. Yoshida (eds.), Proceedings of the workshop on the fate and impact of marine debris, 26-29 November 1984, Honolulu, Hawaii, p. 198-212. U.S. Dep. Commer., NOM Tech. Memo. F/SWFC-54.

DeLong, R. L., P. J.Gearin, J. L.Bengtson, P. Dawson, and S. D. Feldkamp. 1990. Studies of the effects of entanglement on. individual northern fur seals. In R.S. Shomura and M.L. Godfrey (eds.), Proceedings of the Second International Conference on Marine Debris, p.492-493, 2-7 April 1989, Honolulu, Hawaii. U.S. Dep. Commer., NOAATech. Memo. F/SWFSC-154.

Fowler, C. W. 1985. Status review: Northern fur seals (Callorhinus ursinus) of the Pribilof Islands, Alaska. Natl. Mar. Mammal. Lab., Northwest Alaska Fish. Cent., Natl. Mar. Fish. Serv., NOM, Seattle, WA 98115.

Fowler, C.. W. 1987. Marine debris and northern fur seals: A case study. Mar. Pollut. Bull. 18(6B): 326-335.

Fowler, C. W., J. Baker, R. Ream, B. Robson, and M. Kiyota 1993. Entanglement studies, St. Paul Island, 1992 Juvenile male northern fur seals. AFSC Processed report 93-03. Natl. Mar. Mammal. Lab., Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv.,. U.S. Dep. of Commerce. 42p.

Kajimura, H. and T. R. Loughlin. 1988. Marine mammals in the oceanic food web of the eastern subarctic Pacific. Bull. Ocean Res. Inst., Univ.. Tokyo, 26(1):187-223.

Kuzin, A. E. 1990. A study of the effect of commercial fishing debris on Callorhinus ursinus from breeding islands in the western Pacific. In R.S. Shomura and M.L. Godfrey (eds.), Proceedings of the Second International Conference on Marine Debris, p. 475-482, 2-7 April 1989, Honolulu, Hawaii. U.S. Dep. Commer., NOAA Tech. Memo. F/SWFSC-154.

Ribic, C. A., and G. L. Swartzman. 1990. An index of fur seals entanglement in floating net fragments. In R.S. Shomura and M.L. Godfrey (eds.), Proceedings of the Second International Conference on Marine Debris, p.483-491, 2-7 April 1989, Honolulu, Hawaii. U.S. Dep. Commer., NOAA Tech. Memo:F/SWFSC-154.

Scheffer,V.B. 1950: Growth layers on the teeth of pinnipedia as an indication of age. Science. Wash., 112(2907): 309-311.

Scordino, J. 1985. Studies on fur seals entanglement, 1981-1984, St. Paul Island, Alaska. In R.S. Shomura and H.O. Yoshida (eds.), Proceedings of the workshop on the fate and impact of marine debris, 26-29 November 1984, Honolulu, Hawaii, p. 278-290. U.S. Dep. Commer., NOAA Tech. Memo. F/SWFC-54.

Yoshida, K., and N.Baba. 1985. A survey of drifting stray fishing net in the northern Sea of Japan (Western Pacific Ocean). Far seas Fisheries Research Laboratory, Shimizu, 424, Japan.

Yoshida, K., N. Baba, M. Nakajima, Y. Fujimaki, S. Nomura, and K. Takahashi. 1985. Fur seal entanglement survey report: Test study at a breeding facility, 1983. Far Seas Fisheries research Laboratory, Shimizu, 424 Japan.

Table 1. Entanglement Rate of Northern Fur Seals in the Western North Pacific (WNP) and Okhotsk Sea (OKS), from 1971 to 1987 and 1993.

Mo/Yr	Area	Track Dist. km (A)	# Fur Seals Obsd. (B)	# Fur Seals Ent. (C)	Discvry. Rate/km (C/A) $x10^{-3}$	Ent. Rate (C/B) %
02-06/71	WNP	11259.4	1884	1	0.09	0.05
02-08/72	WNP/OKS	6511.6	2842	1	0.15	0.04
05-08/73	WNP/OKS	5002.1	1441	1	0.20	0.07
07-09/74	OKS	3589.7	1915	0	0.00	0.00
07-10/75	OKS	6772.4	2660	6	0.89	0.23
08-11/76	OKS	4888.9	1521	3	0.61	0.20
11-12/77	WNP/OKS	2251.7	120	0	0.00	0.00
01,05-08/78	WNP/OKS	3520.7	2125	2	0.57	0.09
11-12/79	WNP/OKS	1382.7	92	0	0.00	0.00
01-08/80	WNP/OKS	6130.5	3878	1	0.16	0.03
11-12/81	WNP	1297.7	243	0	0.00	0.00
01-03, 07-08/82	WNP/OKS	4257.2	3639	2	0.47	0.05
02, 11-12/83	WNP/OKS	1938.9	826	1	0.52	0.12
01-03/84	WNP	2065.0	7816	1	0.48	0.01
01-02/85	WNP	412.3	954	0	0.00	0.00
01-02/86	WNP	1152.9	1017	1	0.87	0.10
01-02, 04-05/87	WNP	5903.4	2498	1	0.17	0.04
04/93	WNP	827.1	647	1	1.21	0.15
Total		69164.1	36218	22	0.32	0.06

Table 2. Biological Data of Fur Seals Entangled in Marine Debris Collected.

Smp	Anml#	Date	Locn	Age/Sex	Ln(cm)	Wt(kg)	Debris
1	694	08/13/72	48°09'N, 144°51'E	2/M	98.7	17.0	Net
2	28	07/07/82	47°55'N, 145°44'E	5/M	149.0	62.0	Trl. Net
3	385	02/29/84	36°33'N, 141°04'E	1/M	98.0	18.5	Trl. Net
4	59	01/08/78	42°17'N, 141°23'E	2/M	99.5	21.0	PP Band
5	97	01/14/78	42°09'N, 141°05'E	2/M	98.5	19.0	Cord
6	3	02/04/71	39°44'N, 142°31'E	7/F	119.0	28.5	Net
7	345	06/27/73	39°45'N, 142°28'E	2/F	90.0	11.5	Net
8	239	07/13/75	48°25'N, 145°10'E	14/F	123.0	43.0	Net
9	185	08/19/76	48°16'N, 144°37'E	4/F	114.0	28.5	Net
10	219	08/22/76	48°25'N, 145°08'E	3/F	106.0	15.0	Net
11	708	08/04/80	48°18'N, 145°20'E	9/F	122.0	36.5	Net
12	---	08/02/82	47°52'N, 145°26'E	23/F	----	----	Net
13	444	08/03/75	48°25'N, 144°15'E	5/F	122.0	32.0	Trl. Net
14	1102	10/13/75	48°01'N, 144°47'E	2/F	92.0	15.0	Trl. Net
15	---	12/05/83	42°34'N, 144°40'E	4/F	118.0	26.0	Trl. Net
16	73	07/10/75	48°12'N, 144°42'E	8/F	120.0	32.0	Gillnet
17	16	01/21/87	38°15'N, 141°58'E	4/F	117.0	26.7	Gillnet
18	158	02/06/86	36°13'N, 141°05'E	7/FP	122.0	38.4	PP Band
19	---	04/27/93	37°12'N, 141°35'E	5/FP	122.0	36.0	PP Band
20	1060	10/12/75	48°26'N, 145°01'E	13/F	129.0	54.0	Cord
21	2	08/04/76	48°07'N, 144°28'E	3/F	104.5	24.0	Cord
22	949	10/06/75	48°19'N, 144°49'E	2/F	94.0	17.0	Cord

M:Male F:Non-pregnant female FP:Pregnant female

Table 3. Number of Northern Fur Seals By Age Entangled in Marine Debris Collected in the Western North Pacific and Okhotsk Sea from 1971-1987 and 1993.

	Male				Female				Grand	
Age	Net	Band	Cord	Tot	Net	Band	Cord	Tot	Tot	%
1	1			1					1	4.5
2	1	1	1	3	3			3	6	27.3
3					1		1	2	2	9.1
4					3			3	3	13.6
5	1			1	1	1		2	3	13.6
7					1	1		2	2	9.1
8					1			1	1	4.5
9					1			1	1	4.5
13							1	1	1	4.5
14					1			1	1	4.5
23					1			1	1	4.5
Total	3	1	1	5	13	2	2	17	22	100.0

Teas, Wendy G. and Wayne N. Witzell

Impacts of Anthropogenic Debris on Marine Turtles in the Western North Atlantic Ocean

Southeast Fisheries Science Center, National Marine Fisheries Service, NOAA, Miami, Florida, USA

Abstract

Impacts on marine turtles due to entanglement and debris ingestion have been documented by Sea Turtle Stranding and Salvage Network (STSSN) participants via observation and/or necropsy of stranded specimens. Data compiled by the STSSN from 1980 through 1992 have been analyzed in an effort to quantify the adverse effects of anthropogenic debris on marine turtles in the western North Atlantic Ocean. All five species inhabiting the data collection area were shown to be affected. Impacts varied based on species, size class, geographic region and season.

Introduction

The data used-in this analysis were collected by the National Marine Fisheries Service (NMFS) Sea Turtle Stranding and Salvage Network (STSSN). This network was established in 1980 to document marine turtle strandings along the U.S. Atlantic and Gulf of Mexico coasts, Puerto Rico and the U.S. Virgin Islands. Data are collected by volunteers who document stranding events in their respective areas and contribute those data to a centralized database located at the NMFS Miami Laboratory.

Data collected by the STSSN are useful in documenting the impacts of anthropogenic debris on marine turtles; however, care must be taken when interpreting these data. Stranding coverage has varied both temporally and spatially and the quality of the data has increased as observers gain experience. These data, therefore, represent a sample of sea turtles affected by marine debris.

Results

Network members examined 676 marine turtles affected by anthropogenic debris from 1980 through 1992 - 260 loggerheads (Caretta caretta), 208 greens (Chelonia mydas), 83 leatherbacks (Dermochelys coriacea), 75 hawksbills (Eretmochelys imbricata), 35 Kemp's ridleys (Lenidochelys kempii) and 15 turtles which were not identified to species.. Geographically, 243 turtles were documented in the Gulf of Mexico, 332 in the southeast U. S. Atlantic, 81 in the northeast U.S. Atlantic and 20 in the U.S. Caribbean. A total of 182 turtles were entangled in monofilament line, 74 were entangled in fish net material, 114 were entangled in trap lines or rope and 46 were entangled in non-fishing gear debris. Non-fishing gear debris included plastic fiber "onion" sacks, burlap bags, plastic bags, plastic six-pack yokes, packing twine, steel cable, aluminum beach chairs and various other materials. A total of 103 turtles ingested plastic pieces or balloons and 94 turtles ingested monofilament line and/or fish hooks. A total of 118 turtles were affected by tar and/or oil.

Citations

Amos, A.F. 1989a. Recent strandings of sea turtles, cetaceans and birds in the vicinity of Mustang Island, Texas. In: C.W. Cailloet and A.M. Landry (eds.), Proceedings of the first international symposium on Kemp's ridley sea turtle biology, conservation and management. TAMU-SG-89-105:51.

Amos, A.F. 1989b. The occurrence of hawksbills (Eretmochelys imbricata) along the Texas coast. In: S.A. Eckert, K.L. Eckert and T.H. Richardson (eds.), Proceedings of the ninth annual workshop on sea turtle conservation and biology. NOM Tech. Memo. F/SEFC-232:9-11.

Balasz, G.H. 1985. Impact of ocean debris on marine turtles: entanglement and ingestion. In: R.S. Shomura and H.O. Yoshida Ws.), Proceedings of the workshop on the fate and impact of marine debris, 26-29 November 1984, Honolulu, HI. NOAA Tech. Memo. F/SWFC-54:387-429.

Bjorndal, K.A., A.B. Bolten and C.J. Lagueux. 1994. Ingestion of marine debris by juvenile sea turtles in coastal Florida habitats. Mar. Poll. Bull. 28:154-158.

Burke, V.J., S.J. Morreale and E.A. Standora. 1993. Diet. of the Kemp's ridley, Leoidochelys kempii, in New York waters. Fish. Bull. 92:26-32.

Carr, A. 1952. Handboook of turtles. The turtles-of the United States, Canada and Baja California. Comstock Publishing Associates, Cornell University Press, Ithaca, New York. 542 pp.

Carr, A. 1987. Impact of nondegradable marine debris on the ecology and survival outlook of sea turtles. Mar. Poll. Bull. 18 (6B):352-356.

Carr, A. and S. Stancyk. 1975. Observations on the ecology and survival outlook of the hawksbill turtle. Biol. Conser. 8:161-172.

Laist, D.W. 1987. Overview of the biological effects of lost and discarded plastic debris in the marine environment. Mar. Poll. Bull. 18 (6B):319-326.

Lutz, P.L. 1990. Studies-on the ingestion of plastic and latex by sea turtles. In: R.S. Shomura and M.L. Godfrey (eds.), Proceedings of the second international conference on marine debris, 2-7 April 1989, Honolulu, HI. NOM Tech. Memo:NMFS-. SWFSC-154:719-735..

Lutz, P.L. and M. Lutcavage. 1989. The effects of petroleum on sea turtles: Applicability to Kemp's ridley. In: C.W. Caillouet and A.M. Landry (eds.), Proceedings of the first international symposium on Kemp's ridley sea turtle biology, conservation and management. TAMU-SG-890105:52-54.

Plotkin, P. and A. F. Amos. 1988. Entanglement in and ingestion of marine debris by sea turtles stranded along the south Texas coast. In: B.A. Schroeder (compiler), Proceedings of the eighth annual workshop on sea turtle conservation and biology. NOM Tech. Memo. NMFS-SEFC-214:79-82.

Plotkin, P. and A.F. Amos. 1990. Effects of anthropogenic debris on sea turtles in the northwestern Gulf of Mexico. In: R.S. Shomura and M.L. Godfrey (eds.), Proceedings, second international conference on marine debris, 2-7 'April 1989, Honolulu, HI. NOAA Tech. Memo. NMFS-SWFC-154:736-743.

Sadove, S.S. and S. J. Morreale. 1990. Marine mammal and sea turtle encounters with marine debris in the New York Bight and northeast Atlantic. In: R.S. Shomura and M.L. Godfrey (eds.), Proceedings, second international conference on marine debris, 2-7 April 1989, Honolulu, HI. NOAA Tech. Memo. NMFS-SWFC-154:562-570.

Shaver, D.J. 1991. Feeding ecology of wild and head-started Kemp's ridley sea turtles in south Texas waters. J. Herpetol. 25:327-334.

Stanley, K.M., E.K. Stabenau and A.M. Landry. 1988. Debris ingestion by sea turtles along the Texas coast. In: B.A. Schroeder (compiler), Proceedings of the eighth annual workshop on sea turtle conservation and biology. NOM Tech. Memo. NMFS-SEFC-214:119-121.

Teas, W.G. 1993. Species composition and size class distribution of marine turtle strandings on the Gulf of Mexico and southeast United States coasts', 1985-1991. NOM Tech. Memo. NMFS-SEFSC-315. 43 pp.

Wershoven, R.W. and J.L. Wershoven. 1992. Stomach content analysis of stranded juvenile and adult green turtles in Broward and Palm Beach Counties, Florida. In: M. Salmon and J. Wyneken (compilers), Proceedings of the eleventh annual workshop on sea turtle conservation and biology. NOAA Tech. Memo. NMFS-SEFSC-302:124-126.

Witzell, W.N. 1989. Research requirements for management of the marine habitat. In: L. Ogren (ed.), Proceedings of the second western Atlantic turtle symposium. NOM Tech. Memo. NMFS-SEFC-226:247-250.

THIRD INTERNATIONAL CONFERENCE ON MARINE DEBRIS

Attendees List

Mr. Walter Adcock
College of William and Mary
306-A Buckroe Avenue
Hampton, VA 23664
Tel: 804-851-6734

Mr. Thomas Ajayi
Assistant Director, Fisheries
Nigerian Institute for Oceanography & Marine Research
PMB 12729, Victoria Island
Lagos, NIGERIA
Tel: 234-01-261-7530
Fax: 234-01-619-517

LTJG Lian Akana, USCG
MARPOL Investigations Officer
U.S. Coast Guard
Building 14, Coast Guard Island
Marine Safety Office, San Francisco Bay
Alameda, CA 94501
Tel: 510-437-3083

Lt. Jr. Gildardo Alarcon Daowz
Biologist/Subdirector/TTE.FRAG.
Armada de Mexico (Mexican Navy)
Eje 2 Ote. tramo Heroica Escuela Naval Mil.
#861 Col. Los Cipreses, Delegacion Coyoacan
Mexico, D.F., C.P. 04830, MEXICO
Tel: 525-684-81-88, ext. 1205/1224
Fax: 525-684-81-88, ext. 1205/1224

Mr. Craig S. Alig
Environmental Engineer, US Navy
Carderock Division
Naval Surface Warfare Center
Annapolis, MD 21402
Tel: 410-293-3526

Mr. Anders Alm
Marine Resource Specialist
World Bank ENVLW, Room S-5127
1818 H Street, N.W.
Washington, DC 20433
Tel: 202-473-5113

Mr. Anthony Amos
Research Associate
University of Texas
Marine Science Institute
P.O. Box 1267
Port Aransas, TX 78373
Tel: 512-749-6720

LTJG Ken Anderson, USCG
Commanding Officer, USCG MSO-Miami
U.S. Coast Guard
51 S.W. 1st Avenue, Suite 501
Miami, FL 33131
Tel: 305-536-5693

Mr. Stefan Andersson
Project Manager
IOC - UNESCO
7, Rue Miollis
78015 Paris, FRANCE
Tel: 33-l-4568-4021
Fax: 33-l-40 569316

Ms. Gael P. Arnold
Director, Island Care New Zealand Trust
Centre for Conservation
Private Bag 92019
University of Auckland
Auckland, NEW ZEALAND
Tel: 09-3737599, ext. 8439
Fax: 09-6231996

Dr. Norihisa Baba
Chief of Fur Seal Section
North Pacific Resources Division
National Research Inst. of Far Seas Fisheries
Fisheries Agency
5-7-1, Orido
Shimizu, Shizuoka, JAPAN 424
Tel: 81-543-34-0715

Mr. Robert Bacon
Coordinator,Marine Extension Program
South Carolina Sea Grant Consortium
287 Meeting Street
Charleston, SC 29401
Tel: 803-727-2075
Fax: 803-727-2080

Mr. William Bailey, Program Manager
Geo-Centers, Inc.
1755 Jefferson Davis Highway, Suite 910
Arlington, VA 22202
Tel: 703-769-1899

Mr. David E. Baird,
Secretary/Treasurer
Clean Islands International
1022 Millidge Avenue,
Saint John, NB E2K 2P6, CANADA
Tel: 506-632-2014
Fax: 506-658-4740

Mr. Jerry Barnett
Regional Consultant, Wider Caribbean
International Maritime Organization
Box 3037, Building 598
Ceiba, PR 00735-93037
Tel: 809-865-4343
Fax: 809-865-1785

Ms. Sabrina Barze
Marine Debris Project Assistant
Center for Marine Conservation
1725 DeSalles St., NW
Washington, DC 20036
Tel: 202-388-4912
Fax: 202-429-5609

Ms. Susan Bartholomew, Executive Director
North Carolina Big Sweep
P.O. Box 550
Raleigh, NC 27602
Tel: 919-856-6686
Fax: 919 856-6685

Ms. Gail Bishop, Park Ranger
Gulf Islands National Seashore
3500 Park Road
Ocean Springs, MS 39564
Tel: 601-875-0074
Fax: 601-872-2954

Dr. Alan Bolten, Research Scientist
Center for Sea Turtle Research
Department of Zoology
University of Florida
Gainesville, FL 32611
Tel: 904-392-5194
Fax: 904-392-9166

Ms. Johanna Boomsma
Administrative Program Coordinator
Center for Marine Conservation
1 Beach Drive, SE, Suite 304
St. Petersburg, FL 33701
Tel: 813-895-2188
Fax: 813-895-3248

Mr. Peter Bormanis, Director
Keep Latvia Tidy Foundation
P.O. Box 48
Jurmala 15, LV-2015, LATVIA
Tel: (3712). 760538 or 754954
Fax: 754954 or 360109

Ms. Marci Bortman, Graduate student
The University of New York at Stony Brook
Waste Management Institute/Marine Sciences Research Center
Stony Brook, NY 11794-5000
Tel: 516-632-8704
Fax: 516-632-8064

Ms. Janis Bowles, Corp. Affairs Mgr.
Berkley
One Berkley Drive
Spirit Lake, IA 51360
Tel: 712-336-1520
Fax: 712-336-5183

Mr. Peter Brandt, External Programs
U.S. Environmental Protection Agency
26 Federal Plaza
New York, NY 10278
Tel: 212-264-7834
Fax: 212-264-8109

Mr. Normand Breton, Senior Surveyor
Pollution Prevention, Ship Safety Branch
Canadian Coast Guard
344 Slater Street, 11th Floor
Ottawa, Ontario KlA ON7, CANADA
Tel: 613-991-3172
Fax: 613-954-4916

Mr. Randy Brown, Executive Director
Clean Islands International
8219 Elvaton Drive
Pasadena, MD 2112293903
Tel: 410-647-2500

Mr. Ronald Bruner
Vice President, Communications and Membership Marketing
The Society of the Plastics Industry, Inc.
1275 K Street, N.W., Suite 400
Washington, DC 20005
Tel: 202-371-5210

Mr. Gordon L. Buck, Operations Supervisor
Carnival Cruise Lines
3655 N.W. 87th Avenue
Miami, FL 33178
Tel: 305-599-4693
Fax: 305-599-8645

CDR Alan Bunn, NOAA
NOAA/Florida Keys Nat'l Marine Sanctuary
P.O. Box 1083
Key Largo, FL 33037
Tel: 305-451-1644
Fax: 305-451-3193

Mr. Paul Carangelo
Environmental Advisor
Port of Corpus Christi
P.O. Box 1541
Corpus Christi, TX 78418
Tel: 512-882-5633
Fax: 512-882-7110

Mr. Brian Carey
Supervisory Park Ranger
National Park Service, Canaveral National Seashore
308 Julia Street
Titusville, FL 32796
Tel: 407-867-4077
Fax: 407-867-4447

Mr. H. Arnold Carr
Marine Fisheries Biologist
Massachusetts Division of Marine Fisheries
18 Route 6A
Sandwich, MA 02563
Tel: 508-888-1155

Mr. James Cathcart, Dir.
Environmental Affairs
ITW Hi-Cone
1140 W. Bryn Mawr Avenue
Itasca, IL 60143
Tel: 708-773-9300

Mr. Warner Chabot
Director, Pacific Region
Center for Marine Conservation
580 Market Street, Ste. 550
San Francisco, CA 94104
Tel: 415-391-6204

Mr. Ruperto Chaparro, Marine Agent
Univ. of Puerto Rico, Sea Grant Program
Marine Recreation - Coastal Tourist Specialist
UPR-RUM Mayguez, Box 5000 Mayaguez
Puerto Rico 00081
Tel: 809-838-8045

LCDR John Clary, NOAA
7600 Sand Point Way, N.E.
Seattle, WA 98026
Tel: 206-526-4127
Fax: 206-526-4004

Mr. James M. Coe
Program Manager
Marine Entanglment Research Program
NOAA/NMFS/AFSC
7600 Sand Point Way NE
Seattle, WA 98115-0070
Tel: 206-526-4009
Fax: 206-526-4004

Mr. Charles Cole, Research Associate
Pennsylvania State University
305 Forest Resources Laboratory
University Park, PA 16802
Tel: 814-863-3577

Mr. Usamah Dabbagh, Sr. Project Officer
LA3[N World Bank
1818 H Street, N.W.
Washington, D.C. 20433
Tel: 202-473-9400
Fax: 202-676-0408

Ms. Angela de la Garza
Special Assistant to the Commissioner
Texas General Land Office
1700 N. Congress, Room 7620
Austin, TX 78701
Tel: 512-463-5108

Mr. Diego Diaz-Martin, Biologist
FUDENA- General Project Coordinator
Apartado Postal 70376
Caracas, 1071-A, VENEZUELA
Tel: 58-2-238-1793
Fax: 58-2-2396547
E-Mail: Fudena@dino.coniut.ve.

Mr. Matt Dillon, Future X
PO Box 49.0366
Key Biscayne, FL 33149
Tel: 305-361-1921

Ms. Anne Marie Drake, Environment Canada
Pollution Reduction Division
Environmental Protection Branch
45 Alderney Drive
Dartmouth, NS B2Y 2N6, CANADA
Tel: 902-426-9064
Fax: 902-426-1976

Ms. Karin Dubsky, Environmental Scientist
Coastwatch Europe Network
Environmental Sciences Unit TCD
Dublin 2, IRELAND
Tel: 353-1-2802501

Mr. Emmett Durrum, Environmental Policy Analyst
2000 14th Street, N.W., 7th Floor
Washington, DC 20009
Tel: 202-939-8115.
Fax: 202-939-7185

Mr. John Edwards, Engineering Manager
Great, Lakes Lighthouse Keepers Assn.
2370 Adare Road
Ann Arbor, MI 48104
Tel: 313-322-0117

Ms. Jean Faris, Editor
North Carolina Sea Grant
Box 8605, NC State University
Raleigh, NC 27695
Tel: 919-515-2454
Fax: 919-515-7095

LCDR Mike Farley, USCG
2100 2nd Street, SW
Washington, DC 20593
Tel: 202-287-0427

Mr. David S. Fletcher
Management Program Specialist
5000 Overlook Avenue., S.W.
Washington, DC 20032
Tel: 202-767-8559
Fax: 202-404-1276

Mr. Bill Foster, Communications Manager
Marine Conservation Society
9 Gloucester Road
Ross-on-Wye, Here-fordshire
HR9 5BU ENGLAND
Tel: 0989-566017

Dr. Charles Fowler, Program Manager
National Marine Mammal Laboratory
7600 Sand Point Way, N.E.
Seattle, WA 98115
Tel: 206-526-4031

Ms. Eileen Gerle, Education Coordinator
Okeanos Ocean Research Foundation, Inc.
278 E. Montauk Hwy., P.O. Box 776
Hampton Bays, NY 11946
Tel: 516-728-4522
Fax: 516-728-4584

Ms. Susan Ghertner
Director, Texas Adopt-a-Beach
1700 North Congress Ave., Room 620
Austin, TX 78704
Tel: 512-463-5285
Fax: 512-863-5233

Dr. Abraham Golik,
Geologist/Department Head
Department of Geology
University of Southern California
Los Angeles, CA 90089-0740
Tel: 310-740-7653
Fax: 213-740-8801

Ginnie & Earl Gottshall (winter)
New Jersey Marine Debris Survey Coordinator
Alliance for a Living Ocean
116 West Heather Road
Bel Air, MD 21014
Tel: 410-838-3748

Ginnie & Earl Gottshall (summer)
205 5th Street
Beach Haven, New Jersey 08008

Dr. Murray Gregory
Department of Geology
University of Auckland
Private Bag 92019
Auckland, NEW ZEALAND
Tel: 64-9-373-7599 ext. 7680

Ms. Laurie Halperin
Pollution Prevention Specialist
Center for Marine Conservation
306-A Buckroe Ave.
Hampden, VA 23664
Tel: 804-851-6734

Ms. Kathy Hart
Director of Communications
North Carolina Sea Grant
Box 8605, NC State University
Raleigh, NC 27695
Tel: 919-515-2454
Fax: 919-515-7095

Mr. Robert Hines, Marine Agent
University of North Carolina Sea Grant Program
Pine Knoll Shores, P.O. Box 3146
Atlantic Beach, NC 28512
Tel: 919-247-4007
Fax: 919-515-7095

Ms. Nerina Holden, Environmental Scientist
National Rivers Authority
Chatsworth Road
Worthing, Sussex ENGLAND
Tel: 0793-725-766

Mr. William Holland
Regional Coordinator
Gulf of Mexico Program U.S. EPA
116 Beach View Drive
Pass Christian, MA 39571
Tel: 601-688-3726

Mr. Dewayne Hollin
Marine Business Mgtmt Specialist
Sea Grant Texas A&M University
1716 Briarcrest #702
Bryan, TX 77802
Tel: 409-3854

Mr. Robert Howard, Chief
Coastal Regulatory Unit U.S. EPA
345 Courtland Street, N.E.
Atlanta, GA 30365
Tel: 404-347-1740

Dr. Maurice Isaacs
Veterinary Officer
Department of Agriculture
Nassau, NP, BAHAMAS
Tel: 809-325-4016

Mr. Peder Jacobsson, Consultant
IOC-UNESCO
UNESCO-l, Rue Meolles-75732
Paris Cedex 15, Paris FRANCE

Mr. Otto James, Chief
Bureau of Sewer Services
DC Department of Public Works
125 O Street, SW
Washington, DC 20003
Tel: 202-727-5696

Mr. Scott Johnson
Fisheries Research Biologist
National Marine Fisheries Service
Auke Bay Laboratory
11305 Glacier Highway
Juneau, AK 99801
Tel: 907-789-6063
Fax: 907-789-6024

Dr. Tomasz Jozwiak
Sopot Ecological Institute
23 Marca 91B/86
Sopot, POLAND 81-82D
Tel: 48-58-20-33-10

Mr. Paul Kirby
Port Manager, 'St. Vincent Port Authority
Chairman, Port Management Association of
Eastern Caribbean States
P.O. Box 1237
Kingstown, ST. VINCENT
Tel: 809-456-1830

Ms. Sharon Kliwinski
Environmental Protection Spec.
National Park Service
1849 C St. NW, Room 3223 (WASO-479)
Washington, DC 20240
Tel: 202-208-4639
Fax: 202-208-4620

Mr. Lawrence Koss
U.S. Navy, CNO-N-75
CNO 452- Pentagon
Washington, DC 20350
Tel: 703-602-2562

Ms. Dana Kubinski
Researcher, Litter Study
Center for Solid and Hazardous
Waste Management
University of Florida
2207 N.W. 13th Street, Suite D
Gainesville, FL 32609
Tel: 904-392-6264

CAPT John K. Kwayu
Chief Marine Officer
Tanzania Harbours Authority
P.O. Box 9184
Dar es Salaam, TANZANIA
Tel: 255-51-46041
Fax: 41-346 Port Reeve

Mr. Jack LaCovey
Director of Communications
The Society of the Plastics
Industry, Inc.
1275 K Street, N.W., Suite 400
Washington, DC 20005
Tel: 202-371-5212

Mr. David Laist
Senior Policy and Program Analyst
Marine Mammal Commission
1825 Connecticut Avenue, NW Rm 512
Washington, DC 20009
Tel: 202-606-5504
Fax: 202-606-5510

Ms. Dana Lamont, President
Lamont Designs & Graphics, Inc.
P.O. Box 555
Stoney Brook NY 11790
Tel: 516-584-4120

LTJG Steven Lang, USCG
Commander, Seventh. Coast Guard.
District
U.S. Coast Guard
Miami, FL 33131
Tel: 305-536-5651
Fax: 305-536-95091

Dr. Shirley Laska
Vice Chancellor for Research
University of New Orleans
Administration Building - Room 208
New Orleans, LA 70148
Tel: 504-286-7155
Fax : 504-286-6298

Dr. Michael Liffmann
Asst. Director
Louisiana Sea Grant College Program
Louisiana State University
Baton Rouge, LA 70808
Tel: 504-388-6290
Fax: 504-388-6331

Mr. Arnolds Luksevics, Chief Expert
State Environmental Expertise
25 Peldu Street, Riga, LV-1494,
LATVIA
Tel: 371-2-227-932
Fax: 371-8-820442

Ms. Lynne MacDonald
Marine Advisor
Virgin Islands Marine Advisory
Service
University of the Virgin' Islands
Eastern Caribbean Center
#2 John Brewers Bay
St. Thomas, VI 00802
Tel: 809-774-3004
Fax: same

Mr. David Manski
Chief Biologist
Acadia National Park
P.O. Box 177
Bar Harbor, ME 04609
Tel: 207-288-5463
Fax: 207-288-5077

Ms. Linda Maraniss
Director of Special Projects
Center for Marine Conservation
1725 DeSales Street, N.W.
Washington, DC 20036
Tel: 202-429-5609

Harry March, USCG
Marpol Petty Officer
USCG MSO - Corpus Christi
U.S. Coast Guard
P.O. Box 1621
Corpus Christi, TX 78403
Tel: 512-888-3165

Dr. Satsuki Matsumura
Director, Oceanography and Southern
Ocean Resources Div.
National Research Inst. of Far Seas
Fisheries, Fisheries Agency
5-7-l- Orido
Shimizu, Shizuoka, JAPAN 424
Tel: 81-543-34-0715
Fax: 81-543-35-9642

Dr. Kenneth McConnell
Department of Agricultural and Resource Economics
University of Maryland
College Park, MD 20746
Tel: 301-455-1282

Mr. Frazer McGilvray
Ex Marine Conservation Society
42 Pitcairn Crescent
Hairmyres, East Kilbride, UNITED KINGDOM
Tel: 03552-31229

Mr. Raul Mederos
CEPPOL Coordinator
IOC/UNEP CAR-RU
14-20, Port Royal Street
Kingston, JAMAICA
Tel: 809-922-9267
Fax: 809-922-9292

Ms. Barbara Miller, Marine Debris Specialist
Center for Marine Conservation
580 Market Street, Ste 550
San Francisco, CA 94104
Tel: 415-391-6204
Fax: 415-956-7441

Mr. John Miller
Chief, Resources Management Division
U.S. Department of Interior
National Park Service
Padre Island National Seashore
9405 S.P.I.D.
Corpus Christi, TX 78418
Tel: 512-949-8173
FAX: 5129

Mr. Yoannis Miskis, VP Operations
Celebrity Cruises
5200 Blue Lagoon Drive
Miami, FL 33126
Tel: 305-262-5159
Fax: 305-267-3501

Mr. Dimitri Mitsatsos, Director General
HELMEPA
5 Pergamon St. SMYRNI
Athens, GREECE 17121
301-934-1717

Mr. Dick Moehl, President
Great Lakes Lighthouse Keepers
P.O. Box 580
Allen Park, MI 48101
Tel: 313-662-1200

Mr. Paul Molinari, Deputy Director, Water Mgmt. Division
U.S. EPA
26 Federal Plaza, Room 805
New York, NY 10278
Tel: 212-264-2513
Fax: 212-264-2194

ENS Tessa Muehllehner, USCG
D17 USCG
P.O. Box 25517
Juneau, AK 99802
Tel: 907-463-2211
Fax: 907-463-2218

Ms. Ellen Ninaber, Director
Workgroup North Sea Foundation
Vossiusstraat 20 III
Amsterdam, 1071 AD NETHERLANDS
Tel: 31-20-6761477
Fax: 31-20-6753806

Dr. Andre Nollkaemper
Faculty of Law
Erasmus Univ., Rotterdam
300DR Rotterdam
The Netherlands
Tel: 31-10-408 26 08
Fax: 31-10-453 29-13

Ms. Kathryn O'Hara, Director
Pollution Prevention Program
Center for Marine Conservation
306A Buckroe Ave.
Hampton, VA 23664
Tel: 804-851-6734
Fax: 804-851-4183

Mr. Erik Olsen, Union Secretary
Pb. 7153 Homansbyen
0307 Oslo, NORWAY
Tel: 22-56-7310
Fax: 22-56-8610

Ms. Michele Paige, Executive Director
Florida-Caribbean Cruise Association
2701 Ponce de Leon Blvd., Suite 203
Coral Gables, FL 33134
Tel: 305-446-7297
Fax: 305-448-0931

Mr. Rodney Paterson, SNR Advisor
Environmental Affairs,
Physical/Chemical Sciences
Department of Fisheries and Oceans
200 Kent Street
Ottawa, Ontario KlA OE6, CANADA
Tel: 613-990-0301
Fax: 613-990-5510

Mr. Rolph Payet
Assistant Director, Pollution Control
Division of Environment
Ministry of Foreign Affairs,
Planning and Environment
P.O. Box 445, Victoria, SEYCHELLES
Tel: 248-224-644

LT Brian Peter, USCG
USCG MSO-Miami
51 S.W. 1st Ave., Suite 501
Miami,FL 33131
Tel: 305-536-5693

Mr. Randall Peterson, Chief
Environmental Programs, Holland American Line
300 Elliott Avenue West
Seattle, WA 98199,
Tel: 206-281-3535

Mr. Johnnie Phillips
Auditor/GAO Evaluator
U.S. General Accounting Office
5029 Corporate Woods Drive, Ste 300
Virginia Beach, VA 23462
Tel: 804-552-8121
Fax.: 804-552-8197

Ms. Margaret Podlich, Project Director/Pollution Prevention.
Center for Marine Conservation
1725 DeSales St. NW,#500
Washington, DC 20036
Tel: 202-429-5609.

Ms. Christiana Prekezes,
Geologist/Training DPT of HELMEPA
HELMEPA, 5 Pergamon Street
Athens, GREECE 17121
Tel: 301-934-3088

Mr. Gregory Rabess
Communications Officer
Small Projects Assistance Team' (SPAT)
P.O. Box 268
Roseau, Commonwealth of Dominica, West Indies
Tel: 809-448-4377
Fax: 809-448-2308

Mr. Jim Ratterree
Environmental Scientist
U.S. EPA, Region 6
1445 Ross Avenue
Dallas, TX 75087
Tel: 214-655-6694

Dr. Gareth Rees
Head, Department of Environmental Management
Farnborough College of Technology
Boundary Road
Farnborough, Hampshire GU14 6SB, ENGLAND
Tel: 02-52-391266
Fax: 02-52-370036

Ms. Jeanett Reid, Evaluator
US 'GAO
5209 Corporate Woods Dri., Ste. 300
Virginia Beach, VA 23624
Tel: 804-552-8214

Dr. Christine Ribic, Research Ecologist
NBS Wisconsin Coop. Research Unit
University of Wisconsin
226 Russell Labs
1630 Linden Drive
Madison, WI 5370691598
Tel: 608-263-6556
Fax: 608-262-6099

Mr. Daniel Richards
Marine Biologist
Channel Islands National Park
1901 Spinnaker Drive
Ventura, CA 93001

Mr. Jack Rivers
Marine Fisheries Specialist
University of Georgia
715 Bay Street
Brunswick, GA 31520-4601
Tel: 912-264-7268
Fax: 912-264-7312

Mr. Martin Robards, Environmental Specialist
ENSR, 4670 Reka, G4
Anchorage, AK 99508
Tel: 907-561-5700
Fax: 907-273-4555

Mr. Daniel Rolleri, Coordinator
International Coastal Cleanup
Center for Marine Conservation
1725 DeSales Room 500
Washington, DC 20036
Tel: 202-429-5609

Dr. Peter Ryan
Fitzpatrick Institute, Univer. of Cape Town
Rondebosch 7700, SOUTH AFRICA
Tel: 27-21-650-2966
Fax : 27-21-650-3295
Email: PRyan@zoo.uct.ac.za

Dr. Eugene Sabourenkov
Science Officer
CCAMLR
25 Old Wharf
Hobart 7000, Tasmania, AUSTRALIA
Tel: 61-02-31-03-66
Fax: 61-02-23-27-14
Email: Eugene-SAB@ANTDIV.GOV.ALI

MS. Rachel Salas Didier
Associate Director of Education and Outreach
NJMSC - Building 22
Fort Hancock, NJ 07732
Tel: 908-872-1300
Fax: 908-291-4483

Ms. Nona R. Schaffner
Assistant General Counsel
Department of Environmental Protection
2600 Blair Stone Road, MS-35
Tallahassee, FL 32399
Tel: 904-921-9705
Fax: 904-487-4938

MS. Inga Scheidemandel
Publication Specialist
Geo-Centers, Inc.
1755 Jefferson Davis Highway, #910
Arlington, VA 22202
Tel: 703-769-1898
Fax: 703-769-1885

Mr. John E. Schuler
Project Manager
Browning Ferris Industries-Shipboard Waste Services
8101 Little York
Houston, TX 77016
Tel: 713-635-7777

Ms. Betsy Schrader, Director
Marine Debris Information Office
Center for Marine Conservation
1725 DeSales St. NW
Washington, DC 20036
Tel: 202-429-5609

CDR Ray Seebald, USCG
District 14, MEP
300 Ala Moan
Honolulu, HI 96850
Tel: 808-541-2118
Fax: 808-541-2166

Ms. Jennifer Sevin, Coordinator
Officer Snook Water Pollution, USCG
2550 Douglas Road, Suite 300-A
Coral Gables, FL 33134
Tel: 305-443-3343

Ms. Elaine Sevin, Assistant Coordinator
Officer Snook Water Pollution, USCG
2550 Douglas Road, Suite 300-A
Coral Gables, FL 33134
Tel: 305-443-3343

Mr. Terry Silampa
Manager, Business Development
AD1
1487 Chain Bridge Road, Suite 304
McLean, VA 22101
Tel: 703-734-9626

Mr. Joth Singh,
Scientist/Coordinator
Caribbean Environmental Health Institute
P.O. Box 1111
Castries, ST. LUCIA
Tel: 809-452-2501
Fax: 809-453-2721

Ms. Janet Slater, Scientific Officer
Tasmanian National Parks and Wildlife Service
GPO Box 44A, Hobart City
Tasmania 7001, AUSTRALIA
Tel: 61-002-333695

Ms. Anne Smrcina, Education-Coordinator
Stellwagen Bank National Marine Sanctuary
14 Union Street
Plymouth, MA 02360
Tel: 508-747-1691
Fax: 508-747-1949

Dr. John Snyder, President
Glacier Bay Outfitters
2275 E. Arapahoe Road, Suite 303
Littleton, CO 80122
Tel: 303-797-0400
Fax: 303-797-0868

Dr. Lundie Spence
Marine Education Specialist
University of North Carolina Sea Grant
Box 8605, NC State Univeristy
Raleigh, NC 2769598605
Tel: 919-515-2454

Dr. Michael Stamper, Veterinarian
National Aquarium in Baltimore
Pier 3, 501 E. Pratt Street,
Baltimore, MD 21202
Tel: 410-576-3853
Fax: 410-576-1080

CAPT Juan Enrigue Suarez-Peredo-Navarrete
Militar/Director/Cap. de Nav. C.G.
Armada de Mexico (Mexican Navy)
Eje 2 Ote. tramo Heroica Escuela Naval Mil.
#861 Col. Los Cipreses, Delegation Coyoacan
Mexico, D.F., C.P. 04830, MEXICO
Tel: 525-684-8188, ext. 1205/1224
Fax: 525-684-8188, ext. 1205

Dr. Shogo Sugiura, Director
Office of Ecosystem Conservation
Fisheries Agency
1-2-1 Kasumigaseki, Chiyoda-ku
Tokyo, JAPAN 100
Tel: 81-3-3502-0736

Dr. Jon Sutinen
Department of Resource Economics
University of Rhode Island
Kingston, RI 02881
Tel: 401-792-4586
Fax: 401-782-4766

Mr. Hideya Suzuki, Technical Counselor
Planning- Division
Japan Marine Fishery Resources Research Center
3-27 Kioi-cho, Chiyoda-ku
Tokyo, JAPAN 102
Tel: 81-3-3265-8301

Dr. R. Lawrence Swanson, Director
Waste Management Institute/Marine Sciences Research Center
The University of New York at Stony Brook
Stony Brook, NY 11794-5000
Tel: 516-632-8704
Fax: 516-632-8064

Mr. Vincent Sweeney
Sanitary Engineer
Caribbean Environmental Health Institute
P.O. Box 1111
Castries, ST LUCIA
Tel: 809-452-2501
Fax: 809-453-2721
ST. LUCIA

Ms. Wendy Teas
Research Fishery Biologist
USDOC/NOAA/NMES/SEFSC/Miami Laboratory
75 Virginia Beach Drive
Miami, FL 33149
Tel: 305-361-4544

Mr. John Tiedemann
Director, Sea Grant Education & Outreach Program
Building 22, Fort Hancock
Sandy Hook, NJ 07732
Tel: 408-872-1300

Mr. Paul Topping
Program Officer
Environment Canada
351 St. Joseph Blvd., 12th Floor
Hull, Quebec KlA OH3, CANADA
Tel: 819-953-0663

Dr. Heather Trulli
Biologist/Research Scientist
Battelle Ocean Sciences
397 Washington Street
Duxbury, MA 02332
Tel: 617-934-0571
Fax: 617-934-2124

Dr. Wayne Trulli
Principal Research Scientist
Battelle Ocean Sciences
397 Washington Street
Duxbury, MA 02332
Tel: 617-934-0571
Fax: 617-934-2124

Dr. Hideki Tsubata
Deputy Director, Fishing Ground Environment
Conservation Division
Fisheries Agency
l-2-1, Kasumigaseki, Chiyoda-ku
Tokyo, JAPAN 100
Tel: 81-1-3-3502-0736

Mr. Allard van Veen, President
Pitch-in Canada
200-1676 Martin Drive
White Rock, BC V4A-6E7, CANADA
Tel: 604-538-0577
Fax: 604-538-3497

Mr. Javier Velez Arocho, Marine Advisor
Sea Grant College Program
P.O. Box 5000
Mayaguez, PR 00681-5000
Tel: 809-832-8045
Fax: 809-265-2880

Dr. Hillary Viders, NAUI/PADI
159 Buckingham Road
Tenafly, NJ 07670
Tel: 201-569-1605
Fax: 201-569-6674

Mr. Ivan Vining, Biometrician
Alaska Department of Fish and Game
211 Mission Road
Kodiak, AK 99615
Tel: 907-486-1861
Fax: 907-486-4969

Dr. Nigel Wace
Australian National University
Department of Biogeography and Geomorphology
Research School of Pacific Studies
Canberra, ACT 0200, AUSTRALIA
Tel: 06 249 1382
Fax: 06 249 4917

Dr. Barry Wade, Scientist
Environmental Solutions, LTD
27 Tobaco Ave.
Kingston 10, JAMAICA
Tel: 809-968-3671
Fax: 809-929-5731

Mr. Richard Wade
Vice President, Env. Health
Princess Cruise Lines
10100 Santa Monica Blvd.
Los Angeles, CA 92667
Tel: 310-553-1770, ext. 6842

Ms. Barbara Wallace
Project Director
A.T. Kearney, Inc.
225 Reinekers Lane, Suite 300
Alexandria, VA 22314
Tel: 703-739-1628
Fax: 703-683-2407

ENS Geoff Warren, USCG
2100 2nd Street, SW
Washington, DC 20593
Tel: 202-267-0419

Ms. Heather Weikart
Fisheries Biologist
NOAA/NMFS/AFSC
7600 Sand Point Way, N.E.
Seattle, WA 98115-0070

Mr. Steve Whitesell
Special Assistant
Environmental Planning
Office of Assistant Secretary of the Navy (I&E)
2211 Jefferson Davis Highway
Arlington, VA 22244-5511
Tel: 703-602-2990
Fax: 703-602-7875

Dr. Judith Winston, Director
Research & Collections
Virginia Museum of Natural History
1001 Douglas Avenue
Martinsville, VA 24112
Tel: 703-666-8653
Fax: 703-632-6487

Dr. Dean Wise
Faculty, College of Pharmacy
University of Michigan
110 Crest
Ann Arbor, MI 48103
Tel: 313-994-5865

Mr. Steve Wise
110 Crest
Ann Arbor, MI 48103
Tel: 313-994-5865

Mr. Alex Wypyszinski, Director, NJSGMAS
P.O. Box 231, CCRU
New Brunswick, NJ 08903
Tel: 908-932-9636 ext. 22
Fax: 908-932-6557

Mr. Arvid Ytrearne, Principal Engineer
NB Kompetanse
P.O. Box 3, 5042 Fjosanger, NORWAY
Tel: 47-55 288700

Mr. Xiaolong Zhang
NJ State University
Department of Economics
105 Carlton Club Drive
Piscataway, NJ 08854
Tel:.908-752-2052

Ms. Jil Zilligen, Manager
Pacific Marine Debris Program
Center for Marine Conservation
319 Lloyd Avenue, Apt. C
Santa Barbara, CA 933101
Tel: 805-963-9844

RECENT TECHNICAL MEMORANDUMS

Copies of this and other NOAA Technical Memorandums are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22167 (web site: *www.ntis.gov)*. Paper and microfiche copies vary in price.

AFSC-

51 CLARY, J. C. (editor). 1995. Poster abstracts and manuscripts from the Third International Conference on Marine Debris, May 8-13, 1994, Miami, Florida, 108 p. NTIS No. PB95-210837.

50 MUNRO, P. T., and R. Z. HOFF. 1995. Two demersal trawl surveys in the Gulf of Alaska: Implications of survey design and methods, 139 p. NTIS No. PB95-195061.

49 STARK, J. W., and D. M. CLAUSEN. 1995. Data Report: 1990 Gulf of Alaska bottom trawl survey, 221 p. NTIS No. PB95-194825.

48 NARITA, R., M. GUTTORMSEN, J. GHARRETT, G. TROMBLE, and J. BERGER. 1994. Summary of observer sampling of domestic groundfish fisheries in the northeast Pacific Ocean and eastern Bering Sea, 1991, 540 p. NTIS No. PB95-190963

47 DORN, M. W., E. P. NUNNALLEE, C. D. WILSON, and M. E. WILKINS. 1994. Status of the coastal Pacific whiting resource in 1993, 101 p. NTIS No. PB95-176467.

46 SINCLAIR, E. H. (editor). 1994. Fur seal investigations, 1993, 93 p. NTIS No. PB95-178943.

45 SINCLAIR, E. H. (editor). 1994. Fur seal investigations, 1992, 190 p. NTIS No. PB95-173472.

44 KINOSHITA, R. K., and J. M. TERRY. 1994. Oregon, Washington, and Alaska exports of edible fishery products, 1993, 52 p. NTIS No. PB95-165924.

43 FERRERO, R. C., and L. W. FRITZ. 1994. Comparisons of walleye pollock, Theragra chalcogramma, harvest to Steller sea lion, Eumetopias jubatus, abundance in the Bering Sea and Gulf of Alaska, 25 p. NTIS No. PB95-155602.

42 ZIMMERMANN, M. , M. E. WILKINS, R. R. LAUTH, and K. L. WEINBERG. 1994. The 1992 Pacific west coast bottom trawl survey of groundfish resources: Estimates of distribution, abundance, and length composition, 110 p. plus Appendices. NTIS No. PB95-154159.

41 ZIMMERMANN, M., P. GODDARD, T. M. SAMPLE. 1994. Resullts of the 1991 U.S.-U.S.S.R. cooperative bottom trawl survey of the eastern and western Bering Sea continental shelf, 178 p. NTIS No. PB95-111589.

40 SIGLER, M. F., and H. H. ZENGER, Jr. 1994. Relative abundance of Gulf of Alaska sablefish and other groundfish based on the domestic longline survey, 1989, 79 p. NTIS No. PB94-204963.

39 ZENGER, H. H., Jr., M. F. SIGLER, and E. R. VAROSI. 1994. Assessment of Gulf of Alaska sablefish and other groundfish species based on the 1988 National Marine Fisheries Service longline survey, 79 p. NTIS No. PB94-204872.

38 LOWRY, L. F., K. J. FROST, R. DAVIS, R. S. SUYDAM, and D. P. DEMASTER. Movements and behavior of satellite-tagged spotted seals (Phoca largha) in the Bering and Chukchi Seas, 71 p. NTIS No. PB94-180684.

37 BUCKLEY, T. W., and P. A. LIVINGSTON. 1994. A bioenergetics model of walleye pollock (Theragra chalcogramma) in the eastern Bering Sea: Structure and documentation, 55 p. NTIS No. PB94-181831.